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COASTAL FISHERIES RESOURCES DIVISION
La Jolla, California

COASTAL EASTERN PACIFIC FISHERIES ENVIRONMENTAL INVESTIGATIONS

Biologist Attends Portuguese Fisheries Week

Fishery Biologist Ronald Dotson attended the 7th annual Fisheries Week at the invitation of the Regional Secretary of Agriculture and Fisheries of the Azores, Portugal. The purpose of the meetings, which were held at the Azores Islands from March 23 to 27, is to acquaint local fishermen with a variety of fishing techniques, scientific ideas and information on species. Fishermen, fishing industry representatives, and scientists from Spain, France, Germany, New Zealand and other countries attended the meetings.

Dotson presented a paper on "Drift gillnetting for swordfish and on board handling and preservation." Swordfish fishing was emphasized during the meeting because it is a species that is underexploited by local fishermen. For the past few years, the Azorean Fisheries Department has been working to develop a fishery for swordfish. In developing the fishery, Dotson spent 3 months in 1984 setting up and instructing local fishermen on the use of a surface longline system. Experimental fishing with this longline has resulted in high catches of over 3 metric tons of swordfish per set, with average catches of about 1.5 kg per hook. (R. Dotson, FTS 893-7085)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

New Estimates of Historical Sardine Abundances Developed

Estimates of sardine spawning biomass have been based on analysis of fishery catches, and extend from 1932 to 1964 when the fishery declined to insignificance. Recent egg surveys, which have been conducted by the California Department of Fish and Game in cooperation with the SWFC, indicate a resurgence in sardine spawning biomass to about 20,000 tons. The period from 1965 to 1985 has been the "dark ages" of the sardine because there is no information available on the extent of the decline or the trajectory of abundances during this period. Fishery

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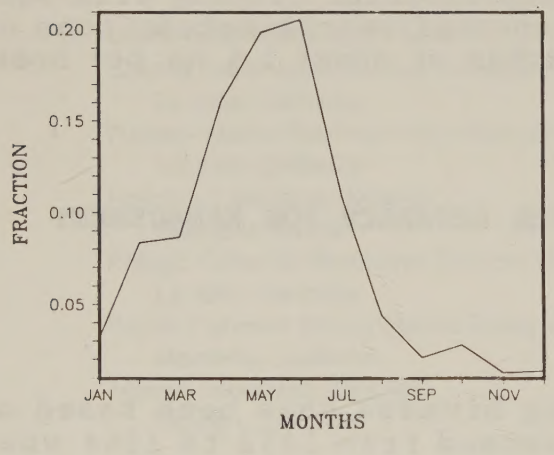
Biologist Alec MacCall has developed a method to estimate sardine abundance during this period, based on larvae sampled during California Cooperative Oceanic Fisheries Investigation (CalCOFI) surveys.

The approach consists of a factorial analysis of variance (ANOVA), which in this case is used mainly to estimate the factors rather than to test hypotheses about those factors. The data consist of average numbers of larvae per surface area for the months, regions, and years covered by the CalCOFI Surveys. The month-region-year matrix contains 12 by 6 by 28 = 2,016 cells, of which 1,192 or 59% contain observations (including zeros), and 41% are missing values. In contrast to most other methods of estimating abundance indexes, the ANOVA treatment is not biased by missing values.

The model predicts each cell value as the product of its respective month, region, and year factors. In effect, the month factors reflect the annual spawning cycle (Figure 1), and the region factors reflect the average geographic distribution of spawning. The year factors reflect relative changes in overall production of eggs and their subsequent survival, and may be taken as an abundance index.



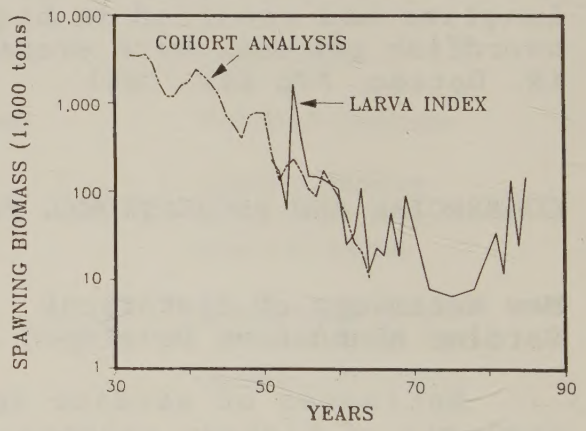


Figure 1. (left) Annual spawning cycle of Pacific sardine, based on ANOVA of abundances of larvae in CalCOFI surveys.
Figure 2. Time series of Pacific sardine abundance (age 2+), based on cohort analysis of fishery landings and an annual index of larva abundance in CalCOFI surveys.

By calibrating the CalCOFI larva abundance index to the fishery-based spawning biomasses for the period of overlap 1951 to 1964, the time series of sardine abundances can be extended up to 1985 (Figure 2, note the logarithmic scale). The calibration is very imprecise, and the true relationship between larva index and spawning biomass may be nonlinear. However, several features are prominent: The abundance reached a low level, probably below 10,000 tons (the lower limit of resolution) during the 1970s, and began increasing toward the end of that decade. The larva index

is now at levels similar to those seen in the 1960s. The 1985 index suggests about 150,000 tons of fish off California and northern Baja California, and has a lower confidence limit of about 20,000 tons. This confirms the State of California's determination that the sardine spawning biomass exceeds 20,000 tons. However, the current abundance estimate from this method should be taken with caution. It is too imprecise to be the basis of short-term management decisions. (A. MacCall, FTS 893-7116)

Annual Tuna Trade Summary Compiled

Samuel Herrick, Industry Economist, has been compiling information on the performance of the U.S. tuna industry during 1986 for inclusion in the forthcoming report "U.S. Tuna Trade Summary, 1986," which will be coauthored with Patricia Donley, Fishery Reporting Specialist, Southwest Region, Wesley Parks, Fishery Biologist, Southwest Fisheries Center, and Earl Weber, Fishery Biologist, Southwest Fisheries Center.

In a reversal of recent trends, U.S. cannery receipts[1] of imported and domestically-caught albacore and tropical tunas rose sharply in 1986, reaching 523,651 short tons (Figure 1). Cannery deliveries by domestic vessels totaled 243,913 tons, up 6% from 1985, while imports of raw tuna rose 16% to 296,548 tons. With the increase in raw tuna supplies, the total pack of canned tuna by U.S. processors reached 32.7 million standard cases,[2] up 17% from 1985. Meanwhile, imports of canned tuna continued to increase during 1986. With the increase in supply, the retail composite canned tuna price, which decreased 2% in 1985, fell an additional 2% during 1986.

The number of vessels in the U.S. tuna fleet continued to decline. At the beginning of 1986, the U.S. tropical tuna fleet consisted of 110 vessels with an overall carrying capacity of 99,594 tons. By year end, the fleet had experienced a 20% loss in numbers, and a 7% decline in capacity. Despite the reduction in fleet, receipts of domestically-caught, light meat tuna totaled 223,666 tons in 1986, 8% above receipts for 1985. This total comprised 90,605 tons of skipjack tuna and 133,061 tons of yellowfin tuna (includes bigeye, bluefin and blackfin tuna). In addition to deliveries to U.S. canneries, U.S. flag vessels

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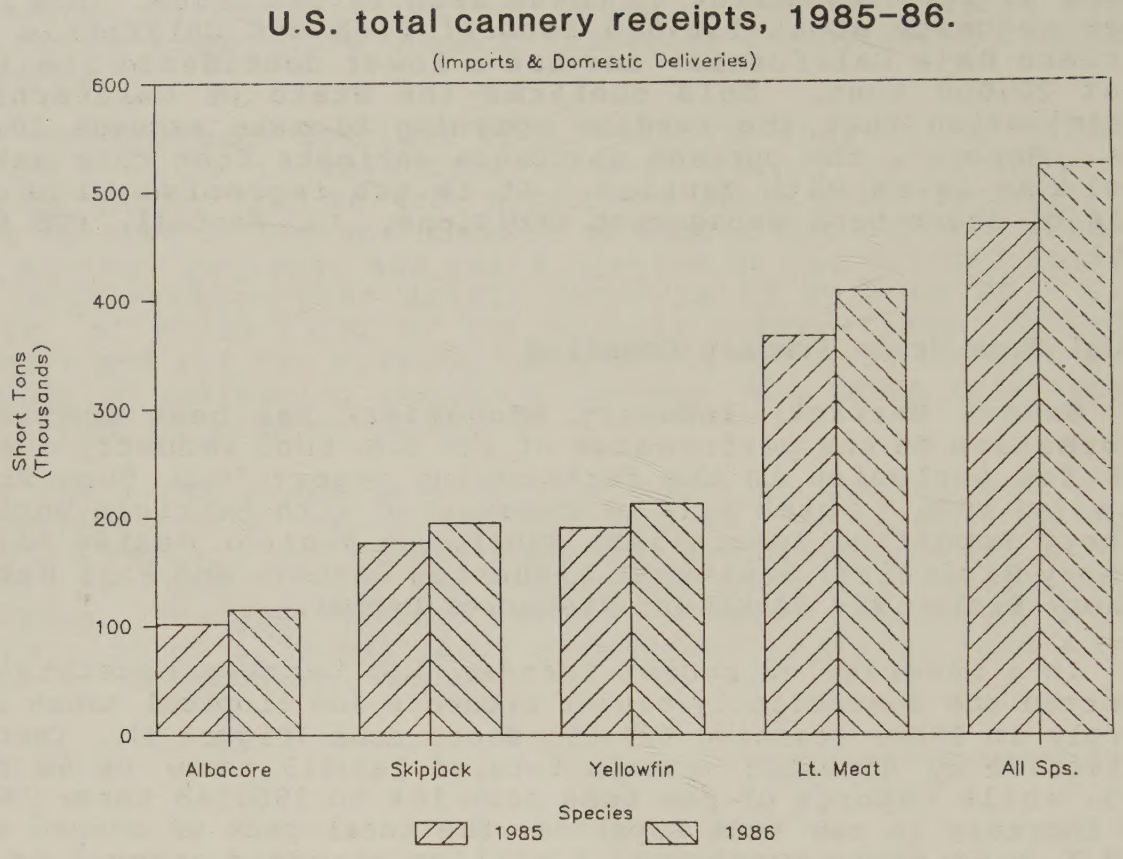
[1]Cannery receipts include only tuna destined for U.S. canneries. Cannery receipts exclude U.S.-caught tuna landed at foreign sites, U.S.-caught tuna landed at U.S. sites that is destined for foreign canneries, U.S.-caught tuna destined for the fresh-fish market, tuna imported as flakes, imported tuna not fit for human consumption, and imported "sushi" grade tuna.

[2]A standard case consists of 48 6.5-ounce cans or 19.5 pounds.



exported[3] 31,304 tons of light meat tuna to foreign canneries in 1986, down 10% from 1985. When exports are combined with domestic deliveries to U.S. canneries, total U.S. deliveries were 254,970 tons, 5% greater than the corresponding amount for 1985.

An important event in August 1986 was the termination of the embargo on U.S. imports of Mexican-caught tuna, which was instituted in July 1980 after Mexico's seizure of U.S. tuna vessels within Mexico's 200-mile territorial fishery zone. Recognizing the potential economic stress that an inundation of exports could impose on the U.S. tuna industry, Mexico voluntarily agreed to limit its exports of tuna products to the U.S., which would presumably consist mainly of frozen light meat tuna, to 19,290 tons (round weight equivalent) from September 1, 1986 to August 31, 1987; 24,802 tons from August 31, 1987, to August 31, 1988; and 30,314 from August 31, 1988 to August 31, 1989.[4] After August 31, 1989, there will be no voluntary restraint on imports.

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[3]Exports include tuna landed directly in or transshipped to a foreign country; excludes tuna exported from the U.S. east coast.

[4]Source: Office of Fisheries Affairs, U.S. State Department.

The immediate effect of Mexico redirecting its exports of frozen tuna to the U.S. will probably be price reductions in the U.S. market for frozen tuna. Because U.S. tuna fishermen have relatively few ex-vessel market alternatives, they will bear the brunt of any price reductions. On the other hand, confronted with lower prices in the U.S. market, foreign (non-Mexican) suppliers will likely divert their exports to other foreign markets that are relatively unaffected by the increase in U.S.-Mexico trade.

Albacore, which is the only species that may be canned as white meat tuna in the U.S., accounted for approximately 25% of the total U.S. canned tuna pack in 1986. The total cannery supply reached 115,819 tons in 1986, 14% above receipts for 1985 and 17% above the 1981-1985 average. The domestic pack of white meat tuna for 1986 amounted to 8.1 million standard cases, 30% above the pack in 1985.

The volume of domestically-caught albacore delivered to U.S. canneries in 1986 totaled 3,527 tons, 49% less than the amount delivered in 1985. U.S. cannery receipts of imported raw albacore totaled 112,292 tons in 1986, an 18% increase from 1985. Imports accounted for 97% of the 1986 total cannery supply of albacore compared with 93% in 1985.

The western Pacific Ocean[5] was the primary production area for the U.S. fleet in 1986, providing 143,777 tons--56% of the domestically-caught cannery receipts and direct exports for the year--an 8% increase in western Pacific deliveries from 1985. The western Pacific was also the area from which most of the raw tuna imports originated in 1986--67,900 tons, 23% of total imports by oceanic area.

The amount of tuna canned in the U.S. was up from 1985, and canned imports set a new volume record in 1986, reaching 12.1 million standard cases. This represents an 11% increase from 1985 and an increase of 170% since 1981. Imports were dominated by tuna packed in water, which is subject to a much lower import duty than tuna packed in oil. When canned imports were combined with U.S. production, the total addition to U.S. canned supplies in 1986 was 44.8 million standard cases, up 15% from 1985.

Bay-Area Sportfish Economic Survey Summarized

Cynthia Thomson, Industry Economist, has completed a descriptive analysis of the questionnaires completed by recreational anglers for the Bay Area Sportfish Economic Study (BASES). This study is being conducted to determine the economic value of sportfishing in the San Francisco Bay area and the Pacific Ocean area around San Francisco.

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[5]The eastern and western Pacific for this report is divided at 150°W longitude.

She found that average trip expenditures on tackle, boat and amenities vary by fishing mode, as follows.

	Average trip expenditures			
	Shore modes		Boat modes	
Expenditure category*	Beach	Pier	Party/ charter	Private/ rental
Tackle	$ 9.79	$ 7.89	$17.11	$12.89
Boat	0.00	0.00	34.92	17.76
Amenities	16.48	9.48	10.67	12.17

*"Tackle" refers to lures, sinkers, lines, rental equipment, licenses, and fish cleaning. "Boat" refers to fuel and fees for private, rental or charter boats. "Amenities" refers to food, beverages and lodging.

The distribution of trips among beach, pier, party/charter and private/rental modes is 28%, 20%, 26% and 26%, respectively, for non-boatowners, and 9%, 10%, 7% and 75% for boatowners. Although boatowners tend to concentrate most of their fishing effort on private boat mode, non-boatowners divide their effort almost equally between all four modes.

The most commonly identified target species or species group in each fishing mode was as follows:

Fishing mode	Target species	% of trips
Beach	No particular	37%
	Striped bass	28%
Pier	No Particular	43%
	Rockfish/lingcod	21%
	Other*	17%
Party/charter Boat	Rockfish/lingcod	38%
	Salmon	32%
Private/rental Boat	Salmon	27%
	Striped bass	23%
	Other*	12%
	Rockfish/lingcod	11%

*"Other" includes all species other than salmon, striped bass, rockfish/lingcod, and halibut/sole/flatfish.

For each of the mode/target species combinations, the catch rate for the targetted species was consistently higher than the catch rates for the non-targetted species. This congruence between motivation and outcome suggests that anglers can and do affect the probability of catching a target species (at least in the short term) by their choice of mode, season, fishing area, fishing method and/or gear.

The BASES results obtained thus far will be distributed as a Technical Memorandum. Thomson's next task will be to model angler behavior to determine what variables affect the individual's decision to participate in recreational fishing, the number of trips made, and switching behavior between fishing modes. The goal of the modeling is to predict changes in volume of angling trips and economic value of the fishery. (C. Thomson, FTS 893-7115)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION
La Jolla, California

Dr. Douglas P. DeMaster Appointed Chief of Fishery-Marine Mammal Interactions Division at SWFC

Dr. Douglas P. DeMaster has been appointed Division Chief of the recently organized Fishery-Marine Mammal Interactions Division. As Division Chief he will be responsible for research on the management of dolphins in the eastern tropical Pacific and coastal marine mammals.

DeMaster received his Ph.D. in 1978 from the University of Minnesota, where he studied the dynamics of Weddell seals in McMurdo Sound, Antarctica. In 1981, he was appointed leader of the Coastal Marine Mammal Program at the SWFC, which had just been created in response to the incidental mortality of sea lions, harbor seals, and elephant seals in a number of coastal fisheries. In working with the National Marine Mammal Laboratory, California Department of Fish and Game, Hubbs Marine Research Institute, and the Southwest Regional Office, DeMaster was successful in initiating a program to monitor population changes at all of the major rookeries, to determine the level of incidental take, and to estimate the magnitude of losses to fishermen as a result of marine mammal interactions.

In 1985, DeMaster went to work with the Marine Mammal Commission in Washington, D.C. as Deputy Director of the Science Program, and in July 1986 Demaster returned to the Southwest Fisheries Center as Leader of the Marine Mammal Assessment Program. Upon his return, the dolphin surveys in the eastern tropical Pacific were about to be launched and data for the assessment of coastal pinnipeds and harbor porpoises were being collected, tasks for which he is now responsible as Chief of the Division.

In addition to DeMaster's position as Division Chief, he is also an adjunct professor in the Biological Oceanography Core Group at Scripps Institution of Oceanography. According to DeMaster, he "looks forward to being part of a state of the art assesssment team that can contribute substantially to research on assessment methods, line transect techniques, life history

analysis, satellite and radio telemetry, stock identification techniques and photogrammetry." His primary goal is to find the proper balance between applied research directed at managing dolphins in the eastern tropical Pacific and coastal marine mammals.

FISHERY DEPENDENT DATA PROGRAM

Oceanographic Data of the ETP Collected during Marine Mammal Cruises

During the 1986 cruises in the eastern tropical Pacific to monitor dolphin abundance, Dr. Steve Reilly, Fishery Biologist, conducted a wide array of ecological sampling techniques aboard the NOAA Ships David Starr Jordan and the McArthur for studying the dolphin habitat. Understanding the dolphin habitat is important for interpreting the trends of the abundance estimates that result from the cruises and for interpreting distribution and abundance results from current studies that are based on data from dolphin observers on tuna vessels.

In analyzing the trends in abundance estimates, it is important to distinguish between changes in the indices of dolphin abundance that result from true changes in dolphin numbers, and changes in one or more characteristics of the dolphin habitat within their geographic range. One such example is the effect of the El Niño oceanographic condition. There appear to be major changes in dolphin distribution as a result of the environmental changes associated with an El Niño.

Scientists from the SWFC are collaborating with researchers from other National Oceanic and Atmospheric Administration (NOAA) laboratories and from universities. Physical oceanic investigations are being led by NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Florida, as part of their larger national and international programs: Equatorial Pacific Ocean Climate Studies (EPOCS) and the Tropical Ocean Global Atmosphere (TOGA) program.

Studies of primary productivity are being conducted jointly with Dr. Richard Barber of the Duke University Marine Laboratory, Beaufort, North Carolina. Barber is also a regular contributor to EPOCS and TOGA, and has a longstanding interest in the relationships between tropical oceanography and biological productivity.

During the 1986 cruise on the David Starr Jordan and the McArthur, Reilly and Fishery Biologist Victoria Thayer collected information on temperature, salinity and fluorescence of surface water (Tables 1 and 2). The information was recorded on strip

Table 1. Disposition and number of samples and data collected on the Jordan during MOPS 1986.

	Chlorophyll[a]	Nutrients	Oxygen	Salinity	Phytoplankton	XBT
Sample quantity	1730 @270ml	1490 @5ml	447 @250ml	447 @250ml	50 @500ml	582
CTD depths	20,40,60,80 100,120,140, 160,180,200m	20,40,60,890, 100,120,140, 160,180,200m	20,500, 1000m	20,500, 1000m	40,80, 120,160	-
Surface	Yes	Yes	No	No	Yes	-
Data disposition	SWFC	Duke Univ.	AOML	AOML	SWFC	AOML
Sample disposition	Disposed	Duke Univ. Mar. Lab.	AOML	AOML	SWFC	Disposed
Total # of sample	1730	1490	447	447	50	582

	Flying fish	Squid	Post-larve fish	Sea turtles (sighted)	Birds (sighted)
Sample quantity	778	Several hundred	Several hundred	837	Unknown as yet
Data disposition	SWFC	SWFC	SWFC	SWFC	SWFC
Sample disposition	SWFC	SWFC	SWFC	-	-
Total	778	Several hundred	Several hundred	837	Unknown as yet

Table 2. Disposition and number of samples and data collected on the McArthur during MOPS 1986.

	Chlorophyll[a]	Nutrients	Salinity	Phytoplankton	XBT
Sample quantity	2,124 @280m	1883 @5ml	947 @250ml	50 @500ml	562
CTD depths	20,40,60,80 100,120,140, 160,200m	20,40,60,890, 100,120,140, 160,200m	20,500, 1000m	40,80, 120,160	40,80, 120,160
Surface	Yes	Yes	Yes	Yes	-
Data disposition	SWFC	Duke Univ. Mar. Lab	Duke Univ. Mar. Lab.	SWFC	AOML
Sample disposition	Disposed	Duke Univ. Mar. Lab.	AOML	SWFC	Disposed
Total # of sample	2,124	1,883	947	50	562

	Birds (sighted)	Turtles (sighted)	Squid
Sample quantity	Unknown as yet	204	nl00
Data disposition	SWFC	SWFC	SWFC
Sample disposition	-	-	SWFC
Total	Unknown as yet	204	nl00

charts and annotated at 6-hour intervals. Discrete water samples were collected at regular intervals to verify continuous data. Hydrocasts were made when the vessel stopped--about two times per night (Figure 1), and six expendable bathythermograph drops were made daily (Figure 2).

Visual censuses of seabirds were conducted about 6 hours per day. Sea turtles were counted and photographed when they were within 300 meters of the trackline. Night-light stations were conducted 92 nights for the collection of flying fishes, squids and post-larval fishes. These samples were frozen and are being analyzed at the Southwest Fisheries Center.

Reilly and Thayer have formulated preliminary results from the information collected on the 1986 cruises. In most parts of the tropical and subtropical oceans, the thermal structure of the upper 1,000 meters is divided into three parts. The first of these, in descending order, is the mixed layer, in which temperature is relatively homogeneous; the second is the thermocline where temperature drops very rapidly; the third is the subsurface layer where temperature continues to drop, but at a much slower rate than in the thermocline.

In the ETP, the 20-degree isotherm is considered the middle of the thermocline. In Figures 3 and 4, the depth of the 20-degree isotherm in the austral summer is depicted as defined from temperature data recorded by the Jordan and the McArthur. The shallow extension of this isotherm reaches out to almost 110°W in September, and by December, extends to more than 130°W. A strengthening of the equatorial counter current produces a ridge, which is developed between the deeper thermocline region at around 10°N, 130°W, and the shallow extension mentioned above. This remains strong to almost 100°W. This ridge, where comparatively small annual variations in surface temperature occur, forms the major east-west axis of spotted and spinner dolphin habitat in the ETP. A study of the area 10° north and south of the equator, at 110°W, is presently in progress.

Reilly and Thayer, collaborating with Barber from Duke Marine Laboratory and Dr. Dave Behringer and Gregg Thomas from AOMC, are studying the biological and physical data from the 1986 MOPS cruises and correlating these with marine mammal sightings from this area.

The McArthur and the Jordan are scheduled to depart for the second year of the marine mammal surveys at the end of July 1987. Oceanographic data similar to those collected during 1986 cruises will be collected in 1987.

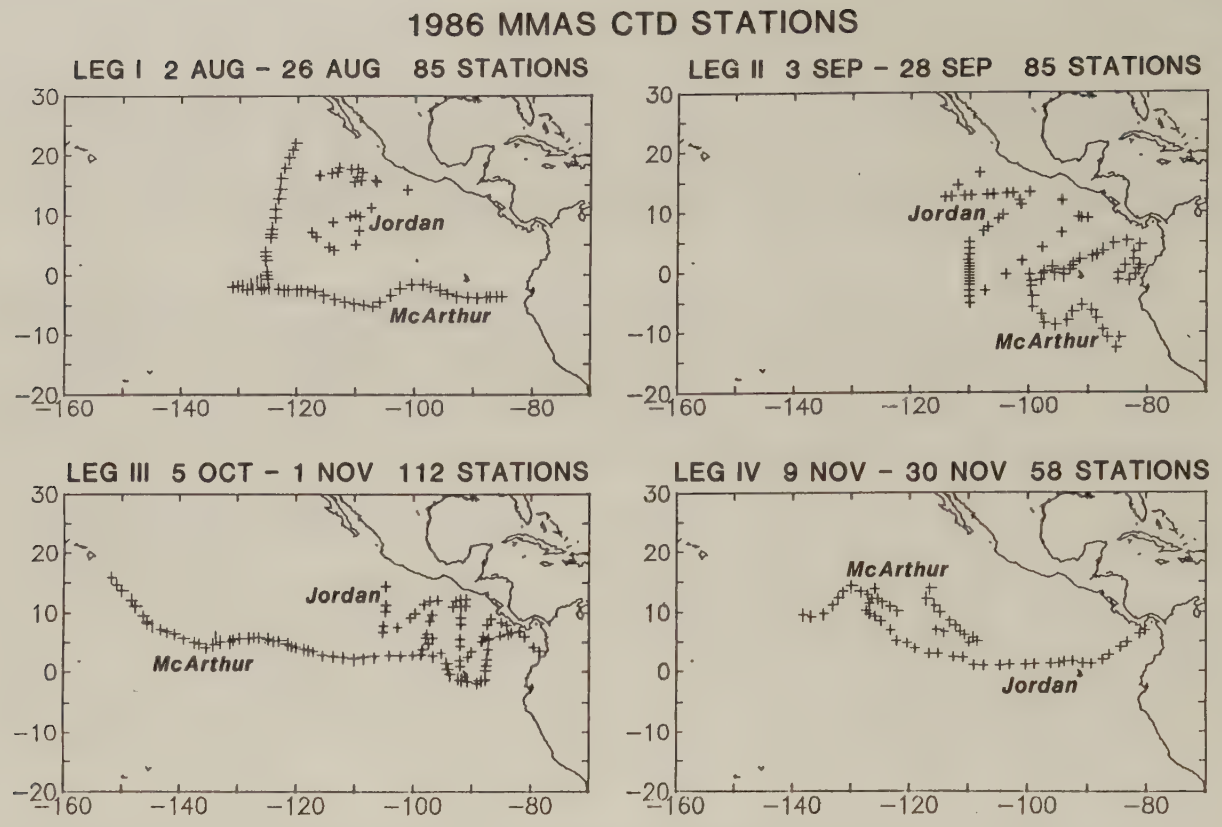


Figure 1. Locations of Jordan and McArthur CTD casts.

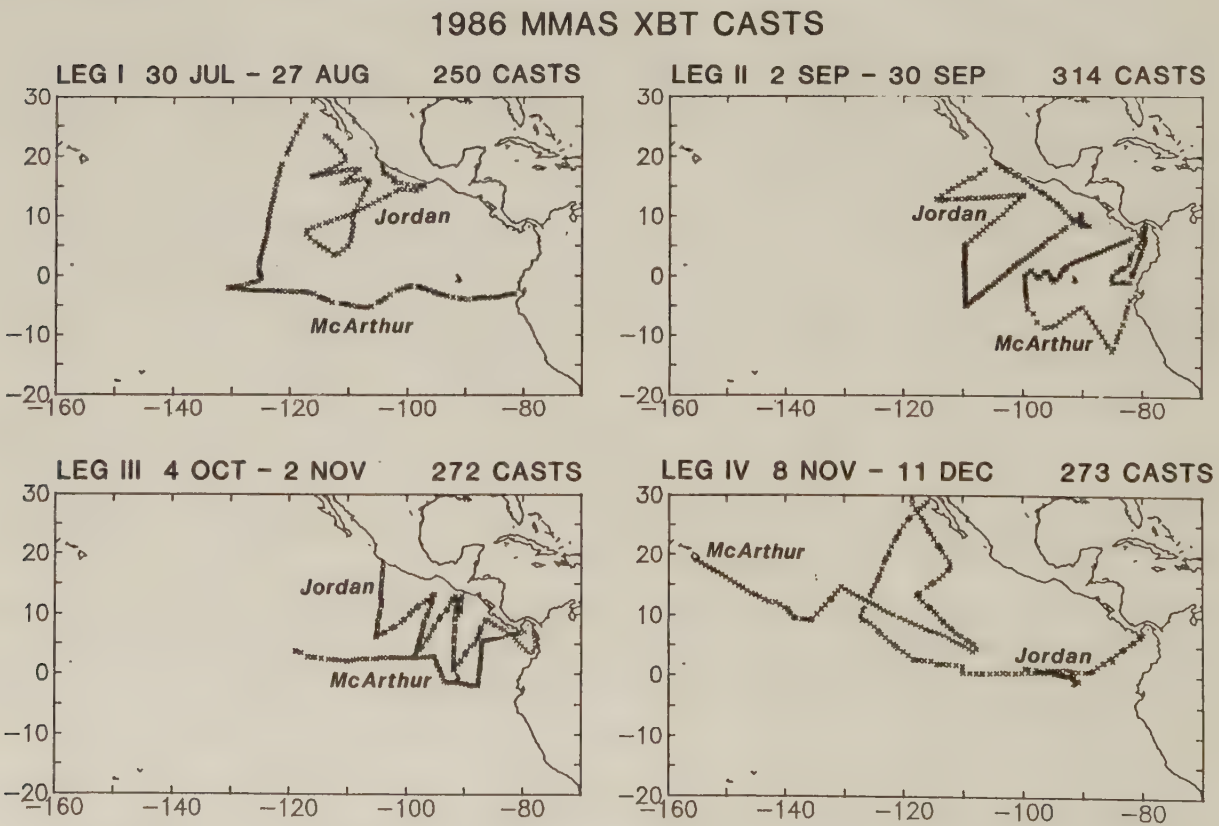


Figure 2. Locations of Jordan and McArthur XBT casts.

Fig. 3 AUGUST/SEPTEMBER 1986 20°C ISOTHERM

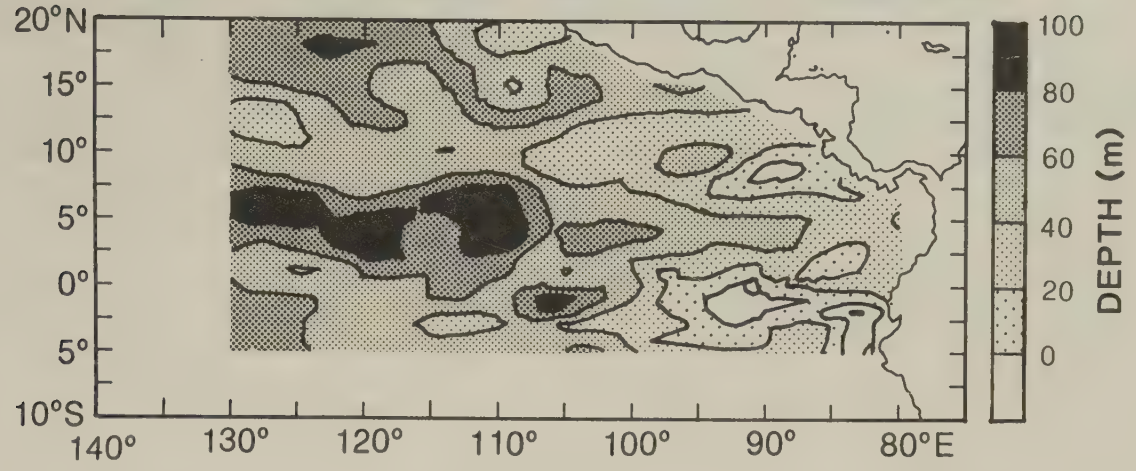
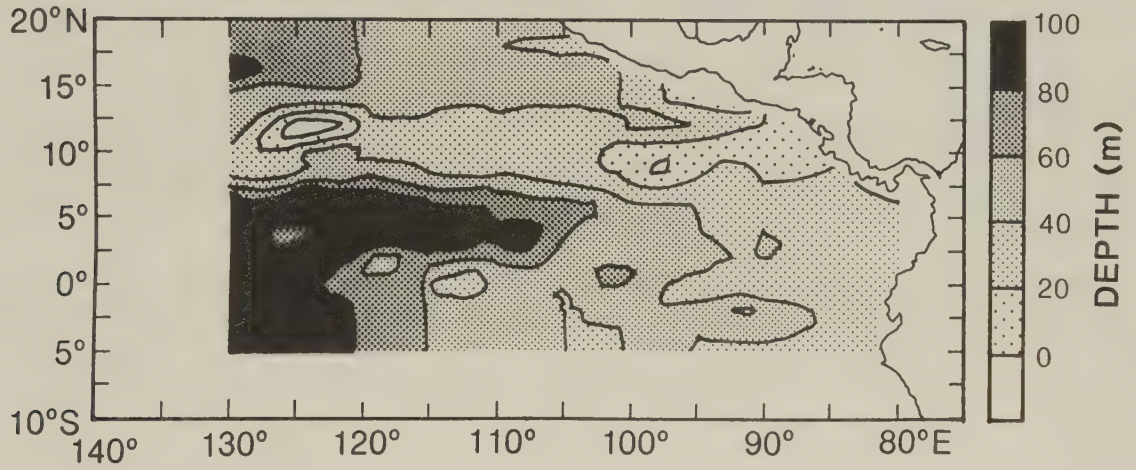


Fig. 4 OCTOBER/NOVEMBER 1986 20°C ISOTHERM



BIOLOGY PROGRAM

Calibrating Dental Layers of Captive Killer Whales to Estimate Age Accurately

To estimate the age of an animal based on the layers that form in teeth over time, the absolute rate of tooth layer deposition must be determined. This tooth layer deposition rate must be calibrated for each species because the rate is different for each species. Dr. Albert Myrick, Wildlife Biologist, Pam Yochem, Hubbs Marine Research Institute, and Dr. Lanny Cornell, Sea World, Inc. have made significant progress in determining the absolute rate of tooth layer deposition in killer whales.

Over the last 2 years, teeth from 14 whales, which had been in captivity for various periods, were studied in decalcified and stained, as well as in untreated, thin sections to determine the amount and layering patterns of tooth tissue that had accumulated

over approximately known discrete time periods. Some of the teeth were labeled with tetracycline (an antibiotic that stains the growth layer being formed at the time it is injected). Using estimates of age at capture based on body lengths, dates of tetracycline treatment, and dates of death or of tooth extraction, Myrick, Yochem and Cornell found that young animals deposited between 800 and 900 μm of a dentinal growth layer group (GLG). The deposition of the tooth layer decreased gradually at about the 6th year, but never went below 700 μm even in very old animals. The implication for age determination is that all examined specimens deposited about the same thickness of a dentinal GLG at the same age. A dentinal GLG in a decalcified and stained section is light with broad, diffuse, darker boundary regions. Cemental layers seem to be deposited at the same rate as dentinal GLGs, but cementum is extremely thin and often may not be useful for age determination. Growth-rate data calculated from GLG counts are mostly similar to those presented by a previous worker, except for the data for the first few years of life. The differences may reflect a systematic bias between counting GLGs from decalcified and stained thin sections and counts made on acid-etched teeth.

The oldest, completely documented age Myrick, Yochem and Cornell were able to establish so far from their sample was 12.5 years. The highest dentinal GLG count they made was 19. For cementum, the highest GLG count made by them was 52, and it was from a wild specimen. However, they expressed reservations that the GLG count may not correspond to age.

To improve confidence in ages estimated from killer whale teeth, the investigators recommend that (1) several teeth from one or two tetracycline-treated whales be extracted over a 2- or 3-year period and examined to more accurately calibrate tooth layer formation rate, (2) a complete row of teeth from one carcass be collected and examined to determine whether layer numbers and patterns are consistent within a single individual, and (3) teeth from old specimens be collected and examined to determine if maximum ages may be accurately estimated. Because the most widely used preparation for making dentinal counts is an etched section, comparisons between GLG counts from decalcified and stained thin sections and "annual layers" described from the dentinal relief of acid-etched teeth should also be made.

These results will be presented by Myrick at a workshop from May 11 to 14 to review progress on various assigned tasks of the "North Atlantic Killer Whale Project." Besides the presentation of results of the various tasks, the workshop will prepare a report of the proceedings to be submitted for review by the Committee on Small Cetaceans of the International Whaling Commission, Scientific Committee in June 1987. (D. DeMaster, FTS 893-7165)

FISHERY INDEPENDENT DATA PROGRAM

SWFC Program Staff Prepares for Second Survey to Monitor Porpoise Abundance in ETP

Preparations for the second survey for monitoring porpoise stocks in the eastern tropical Pacific Ocean are in the final stages. Lt. Pete Stangl, NOAA Corps, Survey Logistics Officer, and Dr. Rennie Holt, Chief Scientist, report that the same two NOAA Ships, David Starr Jordan and McArthur, used in 1986 will be employed for the 1987 survey. Changes have been made which will greatly enhance the usefulness of this year's survey. The most significant factor will be the use of a helicopter to obtain aerial photographs for ground truth school size estimates. NOAA's Office of Aircraft Operations has purchased a Hughes 500D helicopter for use aboard the Jordan, which is being outfitted with a helipad and helicopter-support equipment. School size estimates for observers assigned to the Jordan will be calibrated by comparing the estimates to the actual count obtained from the aerial photographs. After completing two of four survey legs, observers aboard the two ships will switch ships, so all observer school size estimates can be compared.

Survey tracklines for 1987 have been slightly modified from the 1986 tracklines to increase the amount of searching effort and to intensify oceanographic data collection. The major modification is to conduct the survey effort for the McArthur along the 1986 tracklines, but in reverse order. In 1986, the McArthur experienced large swells and high winds because they were heading into the southern trade winds south of the Equator. By reversing the order, the ship will be moving with the wind. (P. Stangl, FTS 893-7168)

HONOLULU LABORATORY

Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Growth of Ornate Jobfish Studied

Over the past 5 years, Program Leader Stephen Ralston has developed and refined an approach to estimating age and growth that is conceptually simple, easy to implement, quick, and relatively inexpensive. As a result, the method has attracted the interest of a number of fisheries biologists studying tropical species in countries throughout the world.

An example of an application of the method is illustrated in some recently completed work on the ornate jobfish, Pristipomoides argyrogrammicus, a deep-sea snapper distributed in the Indo-Pacific from Mauritius to French Polynesia. Biologist Louise Wrobel of Etablissement pour la Valorisation des Activites Aquacoles et Maritimes (EVAAM) in Papeete, Tahiti, sent a collection of ornate jobfish otoliths to the Honolulu Laboratory for help in developing a growth curve. The samples were provided as part of an ongoing comparative growth study at the Honolulu Laboratory of deep-sea snappers throughout the tropical Pacific.

Biological Technician Happy A. Williams determined the average width of presumptive daily growth increments at measured distances to the foci of the otoliths. If increments are formed every day, these data are equivalent to otolith growth rates. The data were pooled (Figure 1) and numerically integrated to produce the mean age of fish following 500 micron intervals of otolith growth. Cumulative otolith length was then regressed on cumulative mean age in a log-log plot, providing a precise empirical description of the average growth of the otolith (Figure 2). This regression was used to predict the length of the otolith at integer values of age.

Estimates of otolith length were converted to estimates of fish length using a simple log-log regression of fish length on otolith length. Williams estimated the ornate jobfish to be 153 mm fork length when 1 year old, 198 mm at age 2, etc. (Figure 3). The data were then fitted to the von Bertalanffy growth curve, resulting in:

$$\text{Fork length} = 412\ (1 - \exp^{-0.165(\text{age} + 1.87)}).$$

This method of determining population growth curves was validated for Pristipomoides zonatus from the Marianas and is now being used regularly to study fish growth patterns. One recurring problem, however, is validation of the daily periodicity of the growth increments for each new species studied. Marking in captivity with agents such as

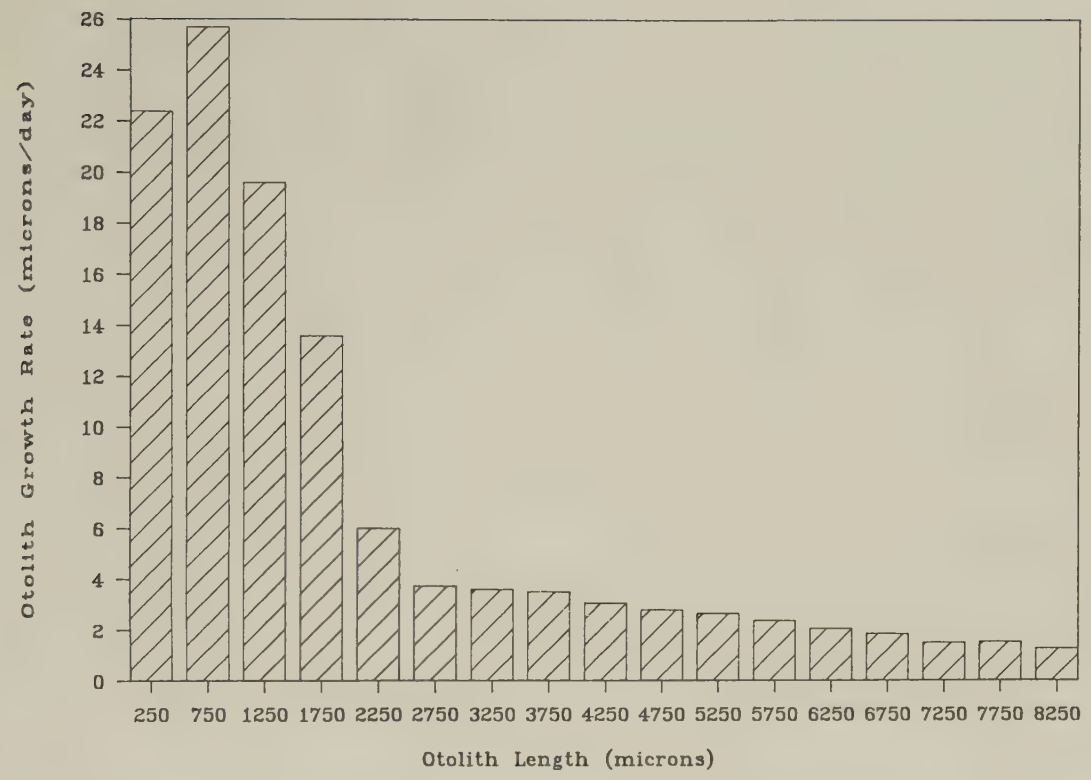


Figure 1. Average growth rates (daily increment widths) of Pristipomoides argyrogrammicus otoliths as a function of otolith size.

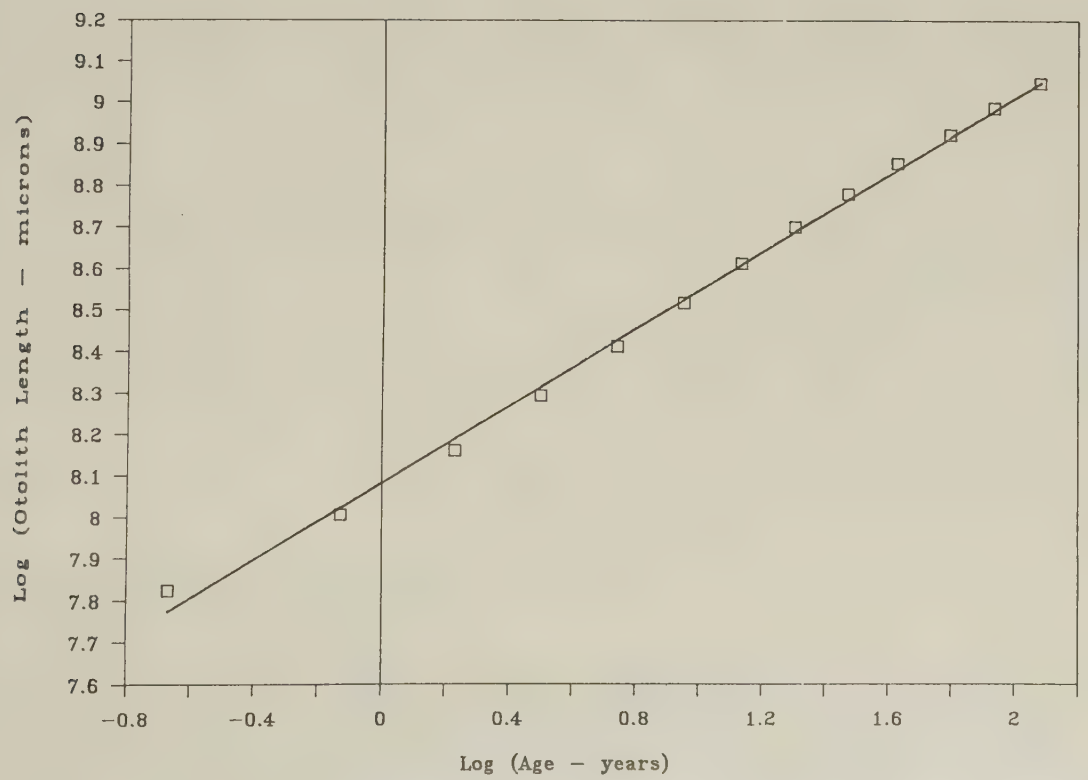


Figure 2. Regression relating otolith size to fish age.

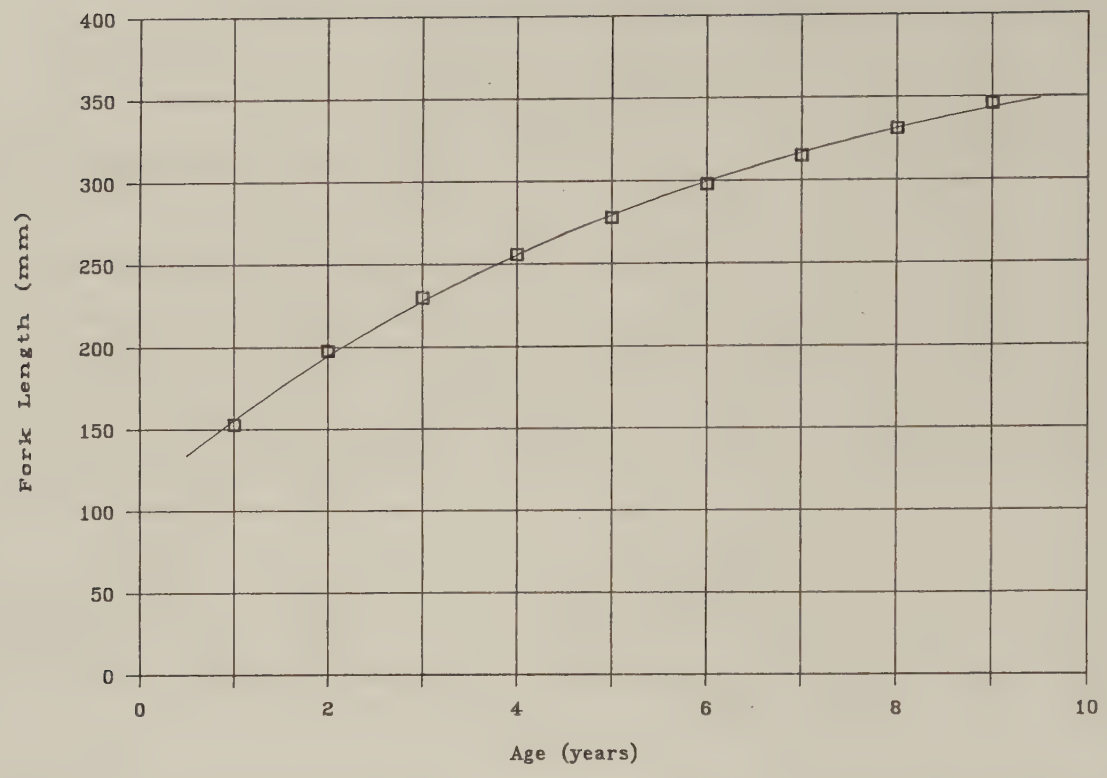


Figure 3. Von Bertalanffy growth curve fitted to age at length data.

oxytetracycline is difficult because these fish typically embolize when brought to the surface. Still, the characteristic bipartite structure of growth increments that has been observed in successful validation studies is useful in interpreting otolith microstructure in other situations.

Dr. Beatriz Morales-Nin of the Instituto de Ciencias del Mar, Barcelona, Spain, is now working with Ralston in a study to compare age estimates derived by four different methods. David Itano of the Office of Marine and Wildlife Resources in American Samoa recently visited the Honolulu Laboratory to study the method, and researchers in Australia and Nigeria have expressed interest in visiting the Honolulu Laboratory to familiarize themselves with the technique. (S. Ralston (808) 943-1259)

Effectiveness of Artificial Reefs Documented for Octopus Fishery in Northern Japan

Dr. Jeffrey J. Polovina, Leader of the Fisheries Enhancement and Dynamics Task, collaborated with Ichiro Sakai of Otaru, Japan, in an analysis of commercial fisheries data from two adjacent regions of Hokkaido, Japan, covering a period both before and after the large-scale deployment of artificial reefs in one of the regions. The purpose of the study was to determine whether there was evidence that artificial reefs can enhance fishery production rather than just aggregate fish. The results

from this study will be used in work at the Honolulu Laboratory on artificial reefs.

Fishermen of the East Shimamaki Fisheries Association and the West Shimamaki Fisheries Association fish adjacent grounds off the village of Shimamaki in Hokkaido, Japan. From 1959 through 1977, 40,766 cubic meters of artificial reefs were deployed off West Shimamaki, and from 1963 through 1985, 8,645 cubic meters of artificial reefs were deployed off East Shimamaki. The artificial reef modules used in both areas were concrete cylinders placed at a depth of 30 to 40 m.

The fishing grounds of the East and West Fisheries Associations share the same environmental conditions, and, during any year, the composition of the fishing fleets of both Associations and the resources fished are similar. Polovina and Sakai evaluated the impacts of the artificial reefs on fisheries for flatfishes, Atka mackerel, and octopus in the two regions by comparing the relative change in catches (and CPUE in the case of octopus) between the two regions as a function of their respective cumulative artificial reef volume. A time series of catch data from 1940 to 1985 for both East and West Shimamaki served as the basis for the evaluation for flatfishes and Atka mackerel, and the catch time series, together with a time series of CPUE from 1965 to 1984, was used for the evaluation of the impact of the artificial reefs on the octopus fishery.

From 1965 to 1975 when most of the artificial reefs were deployed, there was a threefold increase in vessel tonnage in the octopus fleet in both East and West Shimamaki, and octopus catches increased about 7 times in West Shimamaki and 2.5 times in East Shimamaki during the same period. It is estimated that 100 cubic meters of artificial reef volume increased the octopus catches by 1% and an average value of the increase in the catches attributed to the artificial reefs is 2.5 kg per cubic meter of artificial reef volume. For flatfishes and Atka mackerel, however, there was no significant increase in catches between West and East Shimamaki that could be explained by their artificial reef volume. A survey of Shimamaki fishermen's attitudes toward the artificial reefs conducted by Sakai indicates that over 50% of the fishermen regularly use the artificial reefs, 85% felt that the reefs were at least fairly effective in increasing catches, but only 33% felt that the artificial reefs actually increased the catch in the fishing grounds. (J. Polovina (808) 943-1218)

Commercial Shrimp Trapping Data from Hawaii Analyzed

Darryl Tagami, Operations Research Analyst, examined the fishing logs of a catcher vessel fishing for Heterocarpus laevigatus in the Hawaiian Archipelago from 1983 to 1984. The analysis of these data provide a fairly comprehensive mapping survey of the relative abundance of H. laevigatus in the Hawaiian

Archipelago and give a more realistic indication of the magnitude of the shrimp resources than estimates obtained from previous research surveys.

Since its description from a specimen dredged during the 1873-76 voyage of H.M.S. Challenger, the deepwater caridean shrimp, Heterocarpus laevigatus, has been virtually unstudied for nearly a century. From 1968 to 1973, the SWFC Honolulu Laboratory, in cooperation with the University of Hawaii, conducted demersal fishing surveys in Hawaii. Moderate quantities of Heterocarpus sp. were taken, and trapping rather than trawling was shown to be the more effective method of capture. These surveys were exploratory and experimental in nature but allowed Struhsaker and Aasted (1974, Marine Fisheries Review 36(10):24-30) to speculate that deepwater shrimp represent an "unexploited resource of considerable magnitude." By 1982 it was also determined by other researchers that Heterocarpus sp. was widely distributed throughout the central and western Pacific and may have a commercial potential. Further studies by the SWFC Honolulu Laboratory and the State of Hawaii encouraged interest in establishing a deep-sea trap fishery for H. laevigatus and served as a guide for participants in this fledgling fishery.

Early attempts at commercial shrimp trapping in Hawaii, however, were not totally successful. These operations were small, intermittent, and generally suffered from small catches and marketing problems. It is estimated that only 11 metric tons of shrimp were landed from 1970 through 1978. In 1981 shrimp trapping effort and landings increased substantially with the entry of the Hawaiian Shrimp Company into the fishery. The use of a large catcher-processor as a mother ship, which supported three smaller catcher-vessels, enabled this company to operate in the Northwestern Hawaiian Islands as well as in the main Hawaiian Islands from 1983 to 1984 and were largely responsible for the 159 metric tons of H. laevigatus landed in Hawaii in 1984. Unfortunately, financial difficulties forced this company to leave the fishery. Subsequently, the Honolulu Laboratory was presented the opportunity to examine some of the fishing logs of their operation.

Tagami summarized the data from one of the catcher vessels for the 1983-84 field season. From August 1983 to October 1984, the vessel made 10 fishing trips in the Hawaiian Archipelago using newly developed pyramid-shaped shrimp traps. An effort of 6,236 trap-nights produced a total yield of 75.1 metric tons for that fishing season, resulting in an overall CPUE of 12.0 kg per trap-night. Although the vessel was capable of setting and hauling as many as 50 shrimp traps per day, an average of 30 traps were fished daily. A trap loss rate of 3.4% was estimated from the fishing log data.

The vessel fished three different banks in the main Hawaiian Islands and seven in the Northwestern Hawaiian Islands, covering a fishing range of over 800 nmi. Catch rates ranged from a high of 17.1 kg per trap-night at Niihau to a low of 3.1 kg per

trap-night at Brooks Banks. Fishing in the main Hawaiian Islands (CPUE = 14.0 kg) appeared to be more productive than in the Northwestern Hawaiian Islands (CPUE = 9.3 kg).

Currently there are no fishery regulations for deep-sea shrimp, although these results can serve as baseline data for management recommendations. These results should also be informative and relevant for future participants in the shrimp fishery, especially with regard to gear design, expected catch, and choice of fishing grounds. (D. Tagami (808) 943-1242)

Armorhead Relative Abundance Estimated Using Hook Timers

During cruises to the (SE) Hancock Seamount in July and October 1986, David Somerton, Fishery Biologist, installed hook timers on longlines for catching armorheads. The timers were used for estimating time of capture. This information was used to recast the problem of estimating catch rates.

Somerton estimated the relative abundance of pelagic armorhead using catch per hour of standardized bottom longlines. Although this approach to stock assessment is used for many other species, it is difficult to apply when either the target species is so abundant that few baited hooks remain when the gear is retrieved (gear saturation) or when a significant portion of the catch is composed of non-target species (species competition). With the time to capture each fish on the longline known, it would be possible to recast the problem of estimating catch rate in terms of a competing risks model such as the catch equation. This model is expressed as:

$$C_{at} = N_0(A/(A+O))e^{-(A+O)t}$$

$$C_{ot} = N_0(O/(A+O))e^{-(A+O)t}$$

where C_t is the cumulative catch of either armorhead (a) or all other species (o) at time t, N_0 is the initial number of baited hooks, and A and O are the instantaneous catch rates of armorhead and all other species. Catch rates are assumed to be proportional to abundance. There are two important properties of this model. First, gear saturation is allowed because catch is an exponential--not a linear--function of time. Second, the catch rates of the target and the competing species are separable because they are estimated simultaneously.

The timers consisted of 1-inch pieces of magnesium welding rod with stainless steel washers attached to both ends. When placed in seawater, the magnesium corrodes rapidly and has a mass loss that is linear with time. Timers were placed inside alcohol-filled, 35 mm film canisters that protected them from saltwater until a fish took the hook and popped the top off the canister. The time distribution of the catch of armorhead and all other species is shown in Figure 4. The peak catch rate

(catch per 5 minute intervals) of armorhead occurs earlier and declines faster with time than the catch rate of the other species. One interpretation of this pattern is that armorhead are sight predators and take the hooks soon after seeing the bait, whereas the other species (mostly dogfish sharks) are smell predators and require longer to find the gear.

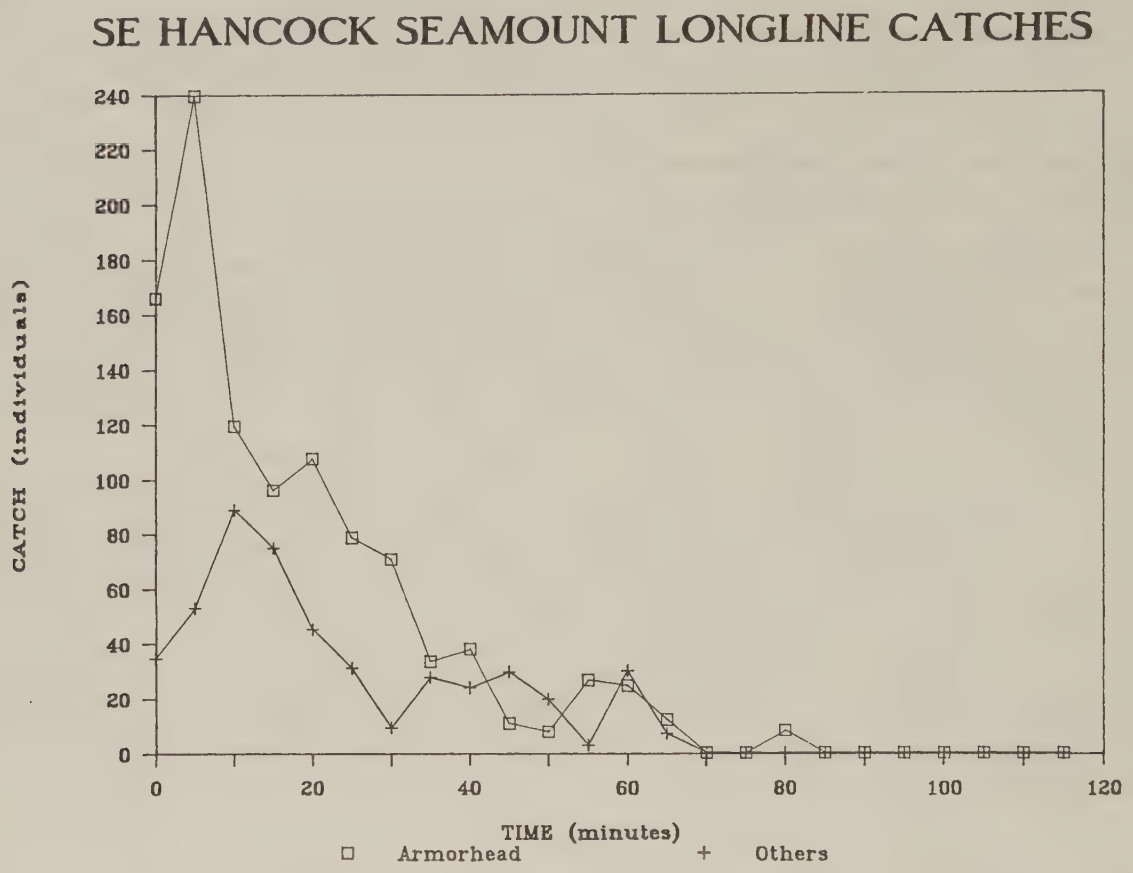


Figure 4. Time distribution of the catch of armorhead and other species.

Recently Chris Wilson of the University of Hawaii developed a timer consisting of a digital watch that is embedded in resin and activated with a magnetic reed switch. Such "clock timers" would be preferable to the corrosion timers because they are reusable and time can be determined directly rather than estimated from mass loss. Ten of these new timers are being field tested on the April 1987 cruise to SE Hancock Seamount. (D. Somerton (808) 943-1215)

Nehu Spawning and Larvae Culture at Kewalo Research Facility

Russell Ito, Biological Technician on the Pearl Harbor water diversion project of the Habitat Task, has maintained a population of Hawaiian anchovy, or nehu, at the Kewalo Research

Facility since August 1986. Ito is maintaining a continuous supply of nehu eggs and larvae for a variety of research projects. Intermittent spawning, without hormone injections, of these fish began in early November and increased in regularity until mid-December when spawning occurred every night. Larvae have been raised to 27 days of age, with the feeding regime switching from Gymnodinium splendens and Nippai artificial plankton to copepods, Eutrapina acutifrons, on day 4 and to rotifers, Brachionus plicatilis, on day 7.

The eggs are being used in a study of egg buoyancy as a function of time. This information will be used to determine the depth at which eggs are neutrally buoyant at various locations in Pearl Harbor. Larvae are now being sampled every day to provide a collection of known-age otoliths, which will be used to determine when the first daily growth ring is formed and to train otolith readers how to interpret the growth increments on the otoliths of larval nehu. In addition, experiments of the survival and growth of nehu larvae at various salinities and temperatures are scheduled to begin in May. (D. Somerton (808) 943-1215)

Onshore-Offshore and Vertical Distributions of Zooplankton Studied

Dr. R. Patrick Hassett, National Research Council Postdoctoral Associate in the Fisheries Habitat Research Program, has made significant progress in the study of biological and physical processes affecting the distribution of four species of copepods, two coastal and two oceanic, in waters off Oahu.

Using samples taken in 1985-86 with the MOCNESS net, near the site of the proposed Ocean Thermal Energy Conversion facility in leeward Oahu, Hassett has shown clear patterns in copepod distribution in the onshore-offshore direction. Labidocera madurae and Undinula vulgaris, the coastal taxa, are much more abundant at the station 2 km offshore than at more distant stations, whereas the oceanic species, Cosmocalanus darwinii and Scolecithrix danae, are more abundant offshore. Vertical distribution varies as a function of distance from shore as well, with a more contracted vertical distribution at the 10 km as opposed to the 30 km station; in particular, the distributions are characterized by a shallower daytime maximum and, at least for Undinula and Scolecithrix, reduced diurnal vertical migration at the 10 km station. Work on this will address seasonality of occurrence and it will be conducted at stations from the windward side of the island. (R. Hassett (808) 943-1248)

Table 1. Abundance of adult females and males of Labidocera madurae, Undinula vulgaris, Cosmocalanus darwinii, and Scolecithrix danae at leeward Oahu stations. Results are given as numbers m^{-2} integrated over 0-160 m (10 and 30 km stations) or 0-80 m (2 km station), except for L. madurae, which is given as numbers 1,000 m^{-3} in the surface 1 m (manta net sample). Only night samples for U. vulgaris are included in the 2 km station estimates because the daytime maximum of these species can exceed 80 m.

	Coastal		Oceanic	
	L. madurae	U. vulgaris	C. darwinii	S. danae
2 km	268	1,382	162	5
10 km	16	25	496	27
30 km	38	71	362	23

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Hawaiian Monk Seal "Head Start" Female Gives Birth at 6 Years

William G. Gilmartin, Leader of the Marine Mammals and Endangered Species Program, reports that one of the four surviving females, which were a part of the first year's pup captive maintenance project (Head Start) at Kure Atoll in 1981, gave birth in March of this year. She is 6 years old and the youngest monk seal known to give birth. Prior to this, the youngest monk seal of known age to give birth was seven. A second large female of the 1981 cohort appears to be pregnant also.

As part of the Head Start Program, the female pups are collected in a beach enclosure at Kure after they are weaned. They are kept in the enclosure during the critical 2 to 5 months between weaning and the end of summer to protect the pups from sharks and aggressive adult male monk seals.

Of the 13 females that have passed through the Head Start project beginning in 1981, 12 have survived through last summer and 1 of these has moved to another atoll.

Additional females have been added to the Kure population beginning in 1985 by relocation of young seals. Underdeveloped pups, collected at French Frigate Shoals during the summer, are rehabilitated in Honolulu through the winter months and released at Kure the following spring. Three such yearling females were taken to Kure on April 14. They will spend a few weeks learning

to catch live fish and invertebrates in a large beach enclosure before final release. (W. Gilmartin (808) 943-1239/1249)

FISHERY MANAGEMENT RESEARCH PROGRAM

WPACFIN Fisheries Data Coordinating Committee Meets in Honolulu

David C. Hamm, Western Pacific Fishery Information Network (WPACFIN) Program Manager, attended the eighth meeting of the WPACFIN Fisheries Data Coordinating Committee (FDCC), which was held in Honolulu March 9 and 10, 1987. Official representatives from all WPACFIN participating agencies were present, except the Guam Division of Aquatic and Wildlife Resources, which had an unofficial representative present. Major topics of discussion were the status of confidentiality agreements in Hawaii, American Samoa and the Commonwealth of the Northern Mariana Islands; the new initiative to obtain additional funding to support Fishery Information Network/WPACFIN and Council-related data collecting and processing activities; the FDCC Technical Subcommittee meeting to be scheduled to work on training for production of Fishery Statistics of the western Pacific; and creation of island modules for the FMP Plan Monitoring Teams. Before the meeting was adjourned, outgoing Chairman Kitty Simonds was recognized by all present for the outstanding job she has done as Chairman. The chairmanship rotated to Ray Tulafono from the American Samoa Office of Marine and Wildlife Resources who performed his first official act as Chairman by adjourning the meeting. (D. Hamm (808) 943-1214)

Annual Report of the Western Pacific Lobster Fishery Completed

The annual report on the lobster fishery of the western Pacific was completed for the Council in March 1987 (Clarke, Raymond P., Peter A. milone and H. E. Witham. 1987. Annual report of the 1986 western Pacific lobster fishery. SWFC Admin Rep. H-87-6). The report summarizes data on the federally administered lobster fisheries in the Northwestern Hawaiian Islands, the main Hawaiian Islands, and the islands of the territories of American Samoa and Guam. The majority of fishing in 1986 took place in the Northwestern Hawaiian Islands, with 58 trips logged. There were only two trips taken in the vicinity of the main Hawaiian Islands and no activity in American Samoa or Guam. All trips originated in Honolulu and the lobster was landed there also; trips lasted from 5 to 88 days.

In 1986, 521 metric tons of spiny lobster, Panulirus marginatus, valued at $3.7 million, ex-vessel, were landed, down from a record 654 metric tons landed in 1985. Slipper lobster

landings of Scyllarides squammosus and S. haanii rose to a record 484 metric tons valued at $2.4 million, ex-vessel. In 1986 the ex-vessel price of spiny lobster tails rose by 10.2% and slipper lobster by 20.1% (unadjusted for inflation). According to the report, the external demand for Hawaiian lobster tails, especially slipper lobster, should be very strong in 1987.

Combined spiny and slipper lobster catch in 1986 was relatively stable, although effort (trap-nights) was up by 33.6% over 1985 effort levels. As a result, catch-per-unit of effort (CPUE) for both species fell: catch per trap-night for legal spiny lobster fell from 1.31 in 1985 to 0.93 in 1986; total slipper lobster catch rates fell from 1.09 in 1985 to 0.85 in 1986. Although the number of active vessels remained the same in 1986 as in 1985 (16), a large segment of the fleet left or were planning to leave for west coast fisheries at the end of 1986. The three most productive banks in terms of numbers of lobsters caught were Maro Reef, Necker Island, and St. Rogatien for spiny lobster and Maro Reef, Brooks Banks, and Gardner Pinnacles for slipper lobster. The report also reviews the seasonality of spiny and slipper lobster fishing, along with the current assessment of the lobster stocks, and describes lobster research being conducted at the Honolulu Laboratory. (R. Clarke (808) 943-1213)

DATA MANAGEMENT AND TECHNICAL SERVICES

Database Training Made Available Via Video

A video is being used at Honolulu Laboratory to train users in dBASE III Plus software. The video is particularly useful for those new to databases or for those familiar with older versions of dBASE. Users are taken step by step through the dBASE commands, beginning with the new ASSIST (menu-driven) mode followed by instructions on use of the interactive (dot prompt) mode. The 8-hour, 2-tape video comes with a training manual and highlights the new dBASE III Plus features including the history command, creation of mailing labels, and the setting up of report formats.

As a result of the training, some researchers are downloading their "mainframe" files to their microcomputers and using dBASE for searching, sorting, and manipulating the data. Training videos for dBASE programming, the DOS operating system, and selected word-processing packages will also be available in the near future. (J. Pappas (808) 943-1260)

T&A On-Line in Honolulu

Honolulu Laboratory successfully sent Pay Period 07 Time and Attendance data electronically to the UNIVAC computer in

Maryland. Although training on use of the T&A software was not scheduled to start until May, Louise F. Lembeck, Editorial Clerk, and Janet L. Pappas, Computer Programmer, worked their way through the training manual, entered the data, and transmitted the TA file--unconventionally--via Kermit-80 on the Molecular by way of Crosstalk on the IBM PC AT. A more direct communication method is being worked out, but having the T&A data on-line has already lightened the workload of the laboratory's timekeeper, Louise Lembeck. (J. Pappas (808) 943-1260)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Climatic Influences on Rockfish Recruitment Studied

Understanding environmental processes affecting recruitment of young fish to commercially important fish stocks is a fundamental objective of fishery research. Oceanographer Jerry Norton has been developing methods for documenting oceanic climatic shifts and relating these shifts to changes in recruitment success of widow rockfish (Sebastes entomelas) and chilipepper (S. goodei) rockfish. Norton inferred recruitment success from otolith aging of commercial catch samples and determined climatic shifts in the physical environment by a combined index derived from seven, well defined physical measurements relevant to the rockfish habitat.

Norton found that different physical conditions are required for optimum widow and chilipepper rockfish recruitment. Certain intermediate years may support moderate recruitment in both species. Widow rockfish recruitment is favored by winters with deep Aleutian Lows, violent winter storms on the coast, above average sea temperatures, enhanced northward flow in the California Current and anomalously high coastal sea level. An El Niño alone, unaccompanied by anomalously deep Aleutian Low development as in 1966 and 1973, does not appear to favor enhanced widow rockfish recruitment. The Aleutian Lows that expand over the coast and bring frequent winter storms with strong winds from the south to intensify coastal downwelling seem more important than the California El Niño in enhancing widow rockfish recruitment.

Chilipepper rockfish recruitment appears to be facilitated by cool water and increased southerly California Current flow conditions. Exceptionally good chilipepper recruitment does not occur in years of exceptionally good widow rockfish recruitment.

The coastal ocean from central California to Vancouver Island has undergone three substantial climatic shifts during the period from 1965 to 1980. First, there was a warm period of 5 years, during which two California El Niños and two Aleutian Low events occurred. In 1970 the two warm event types combined to create conditions that appeared exceptionally favorable to widow rockfish recruitment. After 1970 a shift to an ocean climate of cool sea temperatures and increased southerly flow in the California Current occurred. This cool period lasted until 1976 and included all the most numerous chilipepper rockfish cohorts contributing to the catch from 1978 to 1983. In 1976 the ocean climate shifted back to the warmer regime. Again young-of-the-year widow rockfish survival appears to have been enhanced as California Current warming events became more frequent.

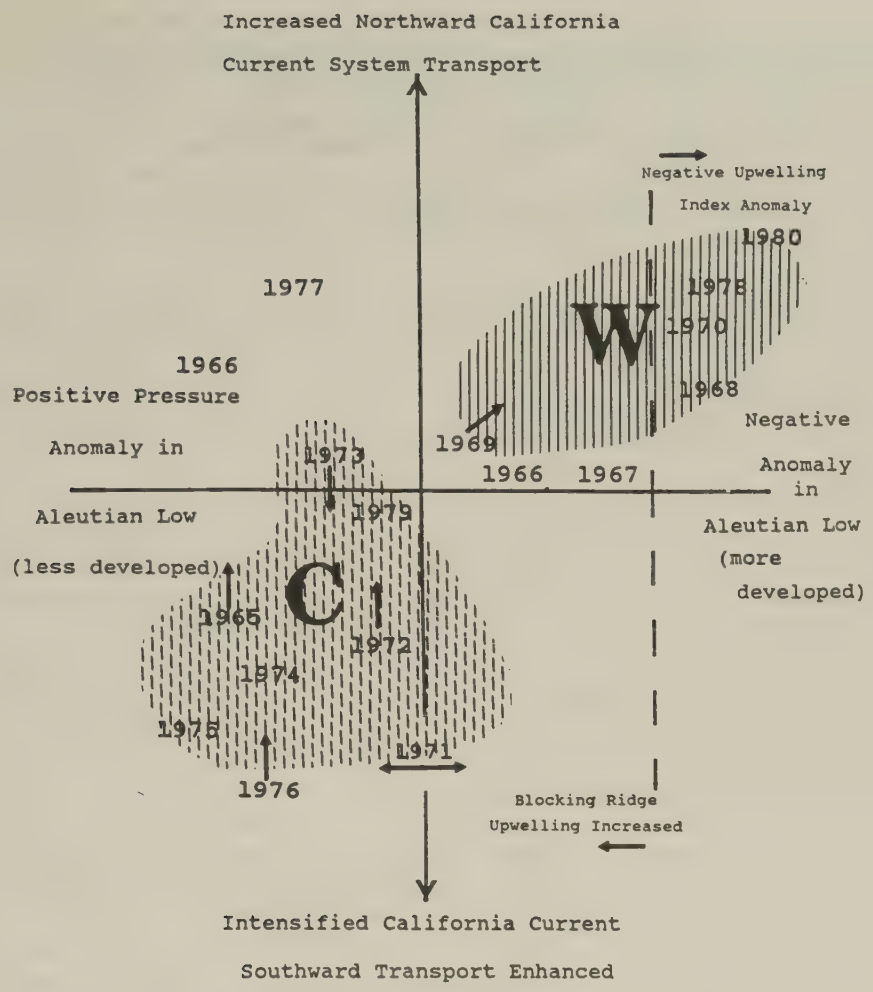


Figure 1. Coordinate system organizing rockfish recruitment data and annual physical parameter tendencies into four quadrants. The verticle axis represents advective current flow in the California Current system. Arrows associated with the date give inferred direction of change in physical environmental conditions during the year. Years that favor chilipepper rockfish are in the the lower left quadrant (broken hatching) and years that favor widow rockfish recruitment are in the upper right quadrant (solid hatching).

Norton summarized his findings in Figure 1, which is a scale-less grid or coordinate system with two main axes. The vertical axis represents advective current flow in the California Current system. Increased northward flow is represented at the top of Figure 1, while increased flow to the south is represented by the space below the horizontal axis. Negative atmospheric pressure anomaly, or an intensified Aleutian Low Pressure System, is represented toward the right on the horizontal axis. Positive anomaly representing a less developed Aleutian Low is to the left. The right side of the horizontal axis is further divided into two areas. When the winter-time Aleutian Low extends over the coastal California Current System, it frequently results in

increased winter downwelling (Figure 1, right of dotted line). The area in the upper right quadrant between the main vertical axis and the dotted vertical ancillary axis would contain years when the Aleutian Low developed but was blocked from the coast by a high pressure ridge as in the 1976-1977 winter. The winters of 1967-1968, 1977-1978, and 1979-1980 would be to the right of the dotted line in the upper right quadrant. The upper left quadrant is the area of California El Niños that occur without Aleutian Low intensification. El Niño years of 1966 and early 1973 would be in this quadrant. If Aleutian Low and El Niño event types occurred together as in 1969-1970, the year would be placed in the upper right quadrant. These years are usually warm with elevated coastal sea level and increased onshore transport in the coastal ocean's surface layers.

The space below the horizontal axis in Figure 1 corresponds to the cool California Current years when transport to the south is enhanced. The lower left quadrant would contain the cool years of the early and mid-1970's. Aleutian Low enhancement is not as frequent or intense during cool periods, so few years will be characteristic of the lower right quadrant. In the 1965-1980 series, 1971 is a possible example. The lower left quadrant contains 1965 (early), 1972 (early), 1973 (late), 1974, 1975, 1976 (early), and 1979, which were definitely cool and largely devoid of warming event influence.

Years that appear to favor chilipepper recruitment are in the lower left quadrant and those that favor widow rockfish recruitment are in the upper right quadrant of Figure 1. The best widow rockfish years are to the right of the dotted line indicating that the best widow rockfish recruitment years have intense coastal winds, which bring warming of the surface layers of the coastal ocean and lead to increased northward transport. Increased onshore, cross shelf transport will accompany increased northward transport. This will carry pelagic larvae and weakly swimming fish in the early juvenile stages toward shore.

Since the processes represented by this grid are the fundamental sources of California Current variability, it is likely that other commercially important marine species will have recruitment success during environmental conditions that can be mapped in definable portions of the gridded space represented by Figure 1.

PELAGIC FISHERY RESOURCES DIVISION

La Jolla, California

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

West Coast Commercial Shark Fishery Reviewed: Man-Eating Sharks!

Because of recent changes in the shark fisheries and a substantial increase in consumer consumption of shark, David Holts, Fishery Biologist, recently completed a review of the major commercial shark fisheries along the Pacific coast. Popularity of shark meat has increased steadily since the late 1970s and has given new meaning to the term "man-eating sharks."

When markets began supplying good quality shark meat, consumer response was enthusiastic. The combined catch of all shark species along the west coast has more than tripled in the last decade (Figure 1). Ex-vessel prices for shark meat rose sharply and several species of shark began supporting important west coast fisheries. Retail prices for thresher shark, for example, increased 500% between 1977 and 1986.

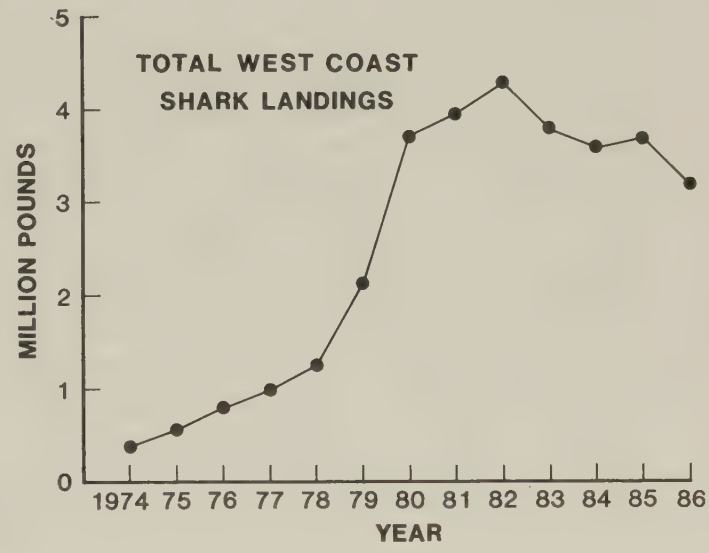


Figure 1.

Generally, sharks are unable to withstand intense fishing pressure because of their slow rate of growth and reproduction and because they are vulnerable to a wide variety of commercial fishing gears. The tremendous success of these shark fisheries raised concerns that some stocks may not be able to sustain the high levels of directed fishing. This is especially important in southern California for common thresher and angel shark fisheries, which are expanding rapidly.

The drift gill net fishery for common thresher sharks (Alopias vulpinus) is centered off southern California between San Diego and San Francisco. It began as a minor operation with only about 15 vessels but topped out at over 200 vessels by 1980, when further expansion was halted with regulations. The ex-vessel price increased from $0.29 per lb. in 1977 to $0.73 in 1980 and reached $1.60 per lb. in 1986. The early growth of this fishery was stimulated by the increasing market value of shark as well as the incidental catches of the valuable swordfish, which contributed to the overall value of a fishing trip.

Before 1986, there were few landings north of San Francisco. Regulations implemented in 1986 to reduce fishing mortality on the southern California thresher shark population, however, caused the fishery to shift dramatically to the north where 33 vessels landed 455,000 lbs. in Oregon and another 200,000 lbs. in Washington. In southern California, landings were limited to 380,000 lbs. of common thresher shark for 1986.

Catch data indicate common threshers may have local population centers that move along the coast in relation to various environmental conditions. This information suggests that this population, as a fishery stock, may be more geographically limited than previously thought. Common thresher landings and catch-per-unit-effort (CPUE) in California have been declining since 1982. Additional evidence that the stocks are not able to support the current level of exploitation comes from signs of a steady decline in average size from 1981 to the present (currently 40 lbs.), and significant reduction in the number of subadult threshers off California. The catch off Oregon and Washington is dominated by large adults averaging over 200 lbs.

It is clear that the thresher shark population along the west coast is not large and that immigration from adjacent waters is not sufficient or rapid enough to sustain the current fishing pressure. The catch has been steadily declining since 1983 and management agencies have determined that thresher sharks may be in a precarious condition. Management recommendations are currently under review and a tri-state agreement to limit fishing is being considered for the 1987 season.

The shortfin mako, Isurus oxyrinchus, known locally as the bonito shark, is taken as a by-catch in the California thresher shark and swordfish fisheries. The annual catch of 200,000-300,000 lbs. is made up almost entirely of juveniles. These small bonito sharks bring a wholesale price of $0.75 to $1.25 per lb. Catch rates, length frequency, and estimates of CPUE provide little information on the magnitude, structure or distribution of the bonito shark stock(s). CPUE estimates are unreliable because they are from fisheries that do not target on this species. There is no evidence that this stock has been significantly affected by current levels of fishing pressure.

The blue shark, Prionace glauca, is not currently a target species of any west coast fishery. However, in the past it was taken in large numbers by various drift gill net fisheries. Early estimates indicated about 20,000 blue sharks were taken annually, although recent estimates are much lower. Gill-net-caught blue sharks are usually not marketable because the fish are usually retrieved dead. Urea in the muscle tissue of blue shark rapidly breaks down after death into ammonia, giving the meat a rancid and unpleasant flavor.

The fishery for the Pacific angel shark, Squatina californica, started in 1978 as an offshoot of the very successful halibut set net fishery near Santa Barbara and the

Channel Islands. This fishery has undergone tremendous growth since initial development and marketing problems for angel shark were worked out. The greatest catch is taken in waters less than 20 miles deep and within one mile from shore. Fishing effort increased markedly in 1982 as the El Niño caused the northern displacement of preferred halibut and other species and the fishermen had to seek alternatives. California landings jumped to 317,000 lbs. in 1982, doubled by 1984, and reached 1.3 million lbs. in 1985. Ex-vessel prices paid to fishermen rose from $0.15 per pound in 1978 to $0.45 in 1984. Landings of 1.1 million lbs. in 1986 marked the first decline in catch since the fishery began expanding.

Although the CPUE estimates are only preliminary at this time, CPUE rates do not appear to be decreasing. The length-frequency of observed catch has just begun to show signs of decreasing mean sizes. The future of this fishery is very much in question. Close scrutiny of this fishery is necessary to prevent what some fishery biologists see as an unavoidable overexploitation of the angel shark resource.

The soupfin shark, Galeorhinus galeus, has supported a commercial fishery for many years. This species supported the great liver oil fishery during the late 1930s and early 1940s, which nearly depleted the stocks off the west coast. There is little information concerning the current population structure, but it is unlikely that stock size has returned to the pre-war levels. The California fishery is centered off San Diego and Orange counties where catches normally exceed 150,000 lbs. In California there are no fishing regulations directed at the soupfin shark other than those imposed on all set nets. Soupfin sharks are also taken in small numbers by related fisheries such as that for halibut, sea bass and angel shark.

COMMERCIAL SHARK LANDINGS-WEST COAST

NAME	1986*	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974
PACIFIC ANGEL	1,139,250	1,237,810	633,250	351,344	317,953	260,031	110,022	123,652	82,383	366	690	2,967	179
THRESHER, BIGEYE	46,184	119,632	74,769	106,507	36,269	10,542	10,842						
BLUE	2,850	2,356	3,940	13,983	57,838	202,898	192,130	83,966	35,904	98,365	9,928	497	46
BONITO	456,063	215,126	244,021	322,953	527,677	275,830	155,336	35,334	27,436	19,911	2,293	9,958	4,032
THRESHER, COMMON	1,215,165	1,528,766	1,662,587	1,757,353	2,386,585	1,937,618	1,806,002	735,602	302,073	129,522	46,887	37,729	2,225
LEOPARD	65,826	75,695	69,187	101,309	70,666	49,380	40,085	26,966	34,956	22,267	14,590	10,831	5,918
THRESHER, PELAGIC	237	640		10,923									
SOUPFIN	197,164	243,661	558,280	176,155	249,070	257,348	192,119	221,840	176,070	162,166	182,390	85,430	42,017
GREAT WHITE	923	2,861	6,102	634	8,052	42	1,660	2,269					
UNSPECIFIED SHARK	135,146	193,317	181,373	181,373	273,721	580,932	1,158,219	840,956	600,473	563,382	582,450	365,849	174,523
ALL OTHERS**	29,644	43,831	114,290	790,301	443,624	352,003	58,063	36,155	45,539	3,559	165	20,000	150
WEST COAST TOTAL LANDINGS	3,288,452	3,663,695	3,547,799	3,812,835	4,371,455	3,926,624	3,724,478	2,106,740	1,304,834	999,538	839,393	533,261	229,090

* Preliminary
** Spiny Dogfish not included.

The economics of elasmobranch fisheries generally require a high level of fishing because of their relative low commercial value and fluctuating market demand. Two populations, the thresher and angel sharks, appear to be fished at very high levels along the west coast and the stocks are overexploited. Other species-stocks appear healthy, even though some warning

signs of overexploitation are appearing. The need for reduced fishing on some stocks and for increased monitoring of catch for others appears warranted. (D. Holts and E. Weber, FTS 893-7186)

Swordfish Fat Offers Clue to Finning Behavior

Fishery Biologists Earl Weber and David Holts have been studying the fat, which is found largely in the crania of swordfish, as a source of insulation that keeps the swordfish's brain warm and thus allows it to spend the daylight hours at great depths in frigid waters. This fat might also hold the clue to swordfish "finning" behavior--that is, floating listlessly at the water's surface with their backs, dorsal fins and the dorsal lobes of their caudal fins protruding above the surface. From the preliminary investigation, Weber and Holts found that fat removed from the crania of freshly caught swordfish underwent a phase change, from a viscous oil at warm temperatures to a gradually solidifying fat at temperatures below 15°C.

When a sample of swordfish fat and an equal quantity of mineral oil (a control) were heated to 26°C and then placed in an ice bath for cooling to a temperature of 15°C, chemical bonds began to form in the swordfish oil/fat. The oil became a cloudy white (Figure 2), and the rate of cooling decreased as cooling

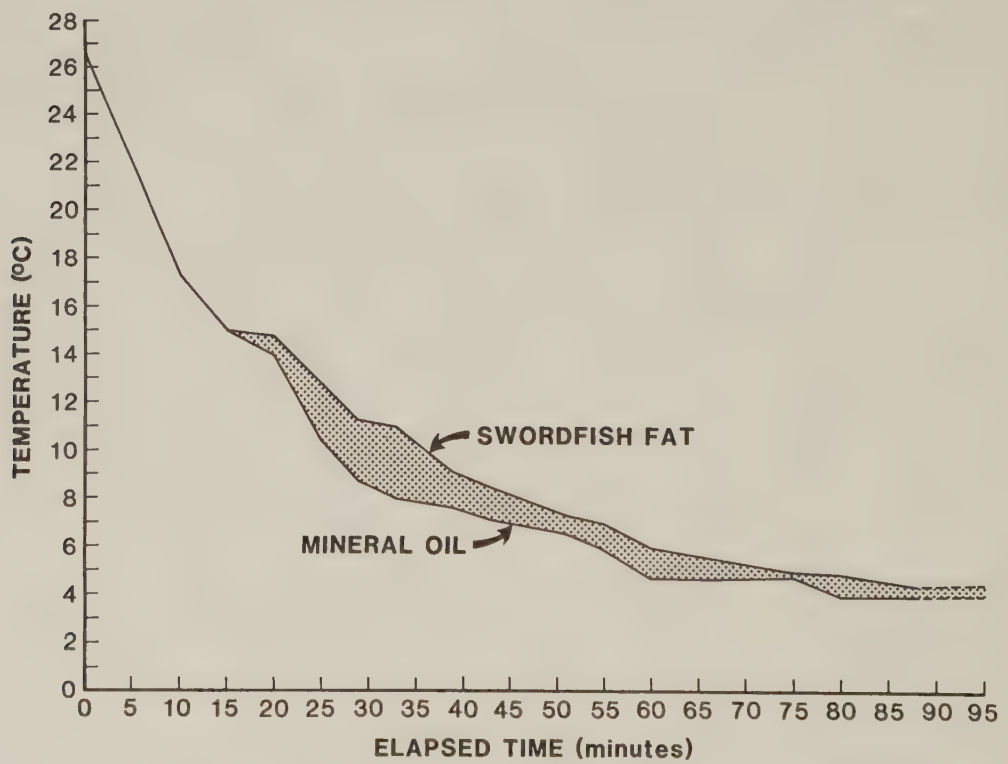


Figure 2. When placed together in an ice bath, the temperature of swordfish fat decreased more slowly than that of mineral oil once the swordfish fat began to form bonds and gradually solidified.

continued. The mineral oil, on the other hand, remained clear and the rate of cooling remained constant. The reason for the slower cooling rate is due to the formation of chemical bonds which generate heat, the so-called latent heat of fusion, and thus retards cooling.

Based on what is known about the behavior of swordfish, the phase change characteristics of the fat could be a mechanism for increasing thermal inertia within the cranium. Swordfish tagged with sonic tags have shown that they typically spend most of the daylight hours at between 300 and 600 meters where temperatures are normally in the vicinity of 8°C. It has previously been determined that these fish have mitochondrion-rich tissue located adjacent to their eyes and brain that warms these organs so that they can continue to function despite the fish's prolonged exposure to cold temperatures. The phase change fat seems to be another adaptation allowing the fish to retain heat in the brain and remain in this environment for longer periods.

The clear disadvantage to such an adaptation is that the fat, once solidified, will also take longer to heat (thaw) than oil would. "Finning" is hypothesized as a mechanism for rapid heating of the fat. The often-observed listlessness of finning swordfish might be attributed to numbness after ascending from deep, colder waters. The finning itself might be considered a behavioral adaptation for warming the fat. Typically, most finning occurs within an hour or two of noon when the sun can provide effective heating of a basking swordfish. Also the dorsal surface of a swordfish is a grayish black to absorb heat effectively, similar to solar collectors. (E. Weber and D. Holts, FTS 893-7075)

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Atlas Completed on the U.S. North Pacific Albacore Fishery, 1961-1980

Anthony P. Majors, Fishery Biologist, has completed an atlas titled "United States North Pacific albacore fishery, 1961-1980," which presents charts and tables that summarize fishing effort, catch, size composition of sampled fish and catch distribution of the albacore, Thunnus alalunga (Bonnaterre), caught by the U.S. North Pacific fishing fleet from 1961 to 1980. The information presented in this report was obtained from logbooks completed voluntarily by fishermen and from interviews with fishermen conducted by state biologists from California, Hawaii, Oregon and Washington at landing sites during the albacore fishing seasons. These samplers also measured and collected length-frequency data at landing.

Statistics covered in this report include catches from the traditional fishing grounds along the U.S. west coast from central Baja California to British Columbia, areas in the central north Pacific, and areas north of Midway Island. The statistics are presented by vessel class, gear, area and time, and the sampling approach used by the three U.S. west coast states and Hawaii in obtaining the information is described. A description of the historical development of the offshore fishery as jigboats ventured westward to the central north Pacific is also presented. This includes information on the number of days fished (effort) and number of fish caught (catch) by vessel class, 1-degree quadrangle, gear and year. Histograms depicting size composition of fish measured are also presented and are drawn on charts at approximately the 5-degree latitudinal band areas where the samples were taken.

Annual statistics on total commercial landings by states were tabulated from sale receipts of albacore sold at canneries in California, Hawaii, Oregon and Washington. From 1961 to 1980, the U.S. North Pacific albacore fishing fleet landed 391,487 metric tons (mt) of albacore in the three U.S. west coast states and Hawaii. This cumulative total in weight represents an average total landing of 19,574 mt a year. Except for 1961 and 1977, the fishery remained fairly stable from 1962 to 1978. Average or better than average total landings were recorded for approximately 16 of the years during this period. Landings declined rapidly in 1977 and reached its lowest in 1979 with landings of 7,104 mt.

During this 20-year period, more than 53% of the total catch was landed in California, 34% in Oregon, 12% in Washington and less than 1% in Hawaii. Approximately 79% of the sampled vessels fishing for albacore in the North Pacific used jigs, 12% bait and 9% used either a combination of bait and jig or other types of gear. Effort and catch sampling coverage (sampled landings/total landings) for 1961 to 1980 averaged 28.6%; length-frequency sampling coverage (measured fish/total landings) averaged 0.7%. Also, during this same period, a seasonal average of 833 vessel landings was sampled for fishing effort and catch either from logbooks or through personal interviews with the fishermen. (A. Majors, FTS 893-7077)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH COMMUNITIES INVESTIGATION

Trophic Ecology of Deep-Slope Fishes under Study

Four species that live together at depths below 100 fm off the California coast--Dover sole (Microstomus pacificus), sablefish (Anoplopoma fimbria), and the shortspine and longspine thornyheads (Sebastolobus altivelis and S. alascanus)--constituted over 40% of the groundfishes other than hake landed in 1986. Because little is known about the biology of these species, staff of the Groundfish Communities Investigation this year conducted a pilot study to determine the feasibility of an in-depth investigation that would consider the trophic interactions and linkages between the species, as well as other aspects of their biology. Joining a recent cruise aboard the NOAA Ship David Starr Jordan off central California, Biological Technician Wayne Samiere sampled stomach contents of specimens taken by trawl for studies of population estimates of Dover sole and sablefish by members of the Coastal Fisheries Resources Division.

The sizes and numbers of the four species, who share the trophic resources in this habitat, increased with depth and peaked at about 500 fm (Figure 1). The shortspine thornyheads

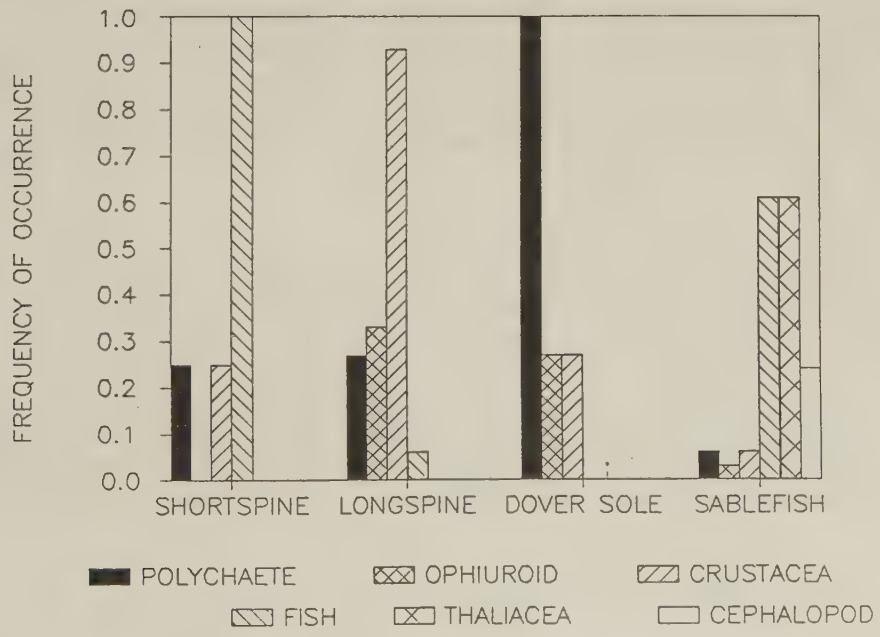


Figure 1. Frequency of occurrence of major prey of slope-community fishes: longspine thornyhead, shortspine thornyhead, Dover sole, and sablefish.

had fed largely on fishes, especially on their smaller relatives, the longspine thornyheads. The longspine thornyheads had, in turn, fed on crustaceans, mainly mysids. The Dover soles had fed largely on polychaetes, thus demonstrating they foraged on the benthos. The sablefish had more varied trophic relations: some had fed on salps and cephalopods, which showed they had foraged in the water column, but others had fed on longspine thornyheads, which showed piscivorous habits near the bottom. Other sablefish had taken brittle stars, which showed they had foraged on the benthos, while still others took combinations of the above, thus demonstrating omnivory (one individual from 100 fm had ingested a cigarette butt).

These data from limited samples indicate that trophic interactions and linkages exist between these fishes and that they can be considered components of a deep-slope community. The feasibility of in-depth study depends on the cruise schedule of the Coastal Division's work with population estimates of Dover sole and sablefish. (P. Adams, FTS 556-0565)

First-Year Juvenile Rockfishes Make Early Appearance in Mendocino Nearshore Habitats

Fishery Biologist Tony Chess and Biological Technician Dan Howard observed young-of-the-year yellowtail rockfish (Sebastes flavidus) and blue rockfish (Sebastes mystinus) in Mendocino's nearshore habitats during the last week in April this year. These observations mark the earliest that these species have been seen in the 9 years that the staff of the Groundfish Communities Investigation has recorded initial appearances of first-year juveniles in Mendocino habitats. During most of these years, their first appearance was in June, and the earliest they had appeared previously was in mid-May in 1985 (an exceptionally strong year for recruitment).

Other species being monitored by their occurrences in the diet of king salmon, however, have not made unusually early appearances. Biological Technician Wayne Samiere reports that first-year juveniles of the shortbelly rockfish (Sebastes jordani), brown rockfish (S. auriculatus), and chilipepper (S. goodei) first appeared in this year's stomach-content samples during mid-April. This is well within the previous extremes of mid-March (1985) and mid-May (1986). (E. Hobson, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Relationship of Year-Class Strength to Reproductive Seasonality and Larval Growth Studied

Each year since 1983, staff of the Groundfish Analysis Investigation have sampled pelagic juvenile rockfishes by midwater trawl to assess year-class strength. A variety of techniques are used to assess year-class strength, including analysis of biological characteristics that may correspond with the size of a year class. Fishery Biologist Tina Wyllie Echeverria has formulated preliminary results on the relationship of year-class strength to reproductive seasonality and larval growth.

Annual reproductive seasonality is monitored by sampling the commercial trawl fishery. Data for percentage of mature females of S. paucispinis, S. entomelas and S. goodei carrying eyed larvae are shown in Table 1. For S. entomelas, the density was

Table 1.--Percentage of mature females containing eyed larvae during the reproductive months in 1984-86 for S. paucispinis, S. entomelas, and S. goodei.

Species	Nov	Dec	Jan	Feb	Mar	Apr
S. entomelas						
1983-84	0	9	18	19	9	0
1984-85	5	42	30	16	9	2
1985-86	4	41	44	35	16	2
S. goodei						
1983-84	0	10	30	23	3	0
1984-85	8	27	28	26	10	4
1985-86	0	0	33	7	3	0
S. paucispinis						
1983-84	0	0	4	11	11	9
1984-85	0	32	40	3	5	2
1985-86	0	0	10	26	10	0

highest in 1985, a year when larval extrusion began in November and peaked in December (very similar to 1986). For S. paucispinis, the highest density was in 1984, a year when larval extrusion was comparatively low. For S. goodei, the highest densities were seen in 1984, a year when larval extrusion began in December and peaked in January. Similar reproductive patterns in species are not necessarily associated with similar densities

of pelagic juveniles (Table 2). Larvae of Sebastes appear to respond differently to conditions after extrusion.

Table 2.--Density (average ln catch per tow + 1) and mean standard lengths (mm) for the principal species caught during the June pelagic juvenile rockfish surveys. For each species (except S. flavidus in 1984), mean length for each year is significantly different from the other years (P = 0.05).

	Density			Mean standard length		
Species	1984	1985	1986	1984	1985	1986
S. entomelas	0.633	2.265	0.208	48.8	53.2	43.4
S. flavidus	0.653	1.079	0.188	42.4	43.1	40.5
S. goodei	0.589	0.450	0.381	46.8	36.5	28.0
S. jordani	1.879	1.981	1.885	45.9	57.6	25.0
S. paucispinis	0.846	0.188	0.607	49.2	63.4	30.6

Biological Technician Carol Reilly compared mean lengths with densities. Instead of smaller fish occurring in the greatest numbers (as might be expected if younger juveniles had been sampled), the opposite was true for three of the species studied (Table 2). In S. entomelas, S. flavidus, and S. goodei, relative ranks of years by density corresponded perfectly with the relative ranks by standard length: the larger the mean standard length, the greater the density. S. paucispinis showed the opposite relationship, with the longest lengths occurring in years with the lowest density. S. jordani always occurred in high density, even though the lengths were statistically different in each year. There appears to be no relationship between density and size in this species. The first three species appear similar in that during a year when conditions are good for survival of the fish to the pelagic stage, then conditions are also favorable for growth.

The impact of early larval extrusion on observed densities will be addressed in greater detail once the ages of these fish have been determined. It is apparent that there are variations in the months of larval extrusion both between species and from year to year. The age determination of daily growth rings is underway by Biological Technician David Woodbury. By determining the birthdates of the juveniles caught in June and knowing the pattern of larval extrusion, Echeverria will be able to determine which releases are successful and begin to look at the environmental conditions that are conducive to larval survival.

The availability of only 3 years of data allows very limited analysis, although interesting trends are emerging. How the data from future cruises fit into the emerging patterns will be reported annually. (T. Wyllie Echeverria, FTS 556-0565)

FISHERIES INFORMATION SYSTEMS & ADP

Staff Complete Local Area Network (LAN) Training

LCDR Herb Kirch, NOAA Corps, and Computer Systems Analyst Frank Ralston attended training in data communications and computer networking this month. The classes, entitled "Introduction to Datacomms and Networks" and "Implementing Local Area Networks," emphasized the importance of standards developed by widely based expert groups such as the International Consultative Committee on Telegraphy and Telephony, the International Standards Organization, and the Institute of Electrical and Electronic Engineers.

The courses covered key protocols and standards, how packet switching networks operate, how local area baseband and broadband networks function, and strategies for interconnecting micros, minis, and mainframe computers. (F. Ralston, FTS 893-6062)

Shipboard Data Collection System Tested at Sea

Computer Systems Programmer Susan Jacobson tested the continuous data collection system at sea on the NOAA Ship David Starr Jordan during the Tiburon cruise in April. The data collection system records oceanographic information such as salinity and temperature and it is currently operating on a 24-hour basis. The staff at Tiburon who used the system reported that the data retrieved during the cruise were accurate and consistent. The cruise also gave ADP staff a chance to expose non-technical users to the operating documentation to determine whether the instructions in the documentation were clear. (S. Jacobson, FTS 893-7060)

STATUS OF PUBLICATIONS

Published

Adams, Peter B. 1987. The diet of widow rockfish Sebastes entomelas in California, pp. 37-41. In William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

The diet of widow rockfish (Sebastes entomelas) taken in the commercial and partyboat fisheries from northern California was examined. The only sampling category that had sufficient numbers to be reliable was the commercial catch from the Eureka area. The diet of these fish is dominated by four prey categories: salps; fish, primarily myctophids; caridean shrimp, almost exclusively Sergestes similis; and euphausiids. There is a seasonal trend in the composition of these four prey categories which corresponds with their life history. There are also size related trends in diet composition. These four major prey groups comprise the deep sounding layer. At night when the widow rockfish are caught at depths of around 140 m, the deep sounding layer is near the surface. This suggests that the widow rockfish is feeding during the day when the deep sounding layer is in deeper waters (400 m). The strong similarity between widow rockfish and blue rockfish (Sebastes mystinus) is pointed out, which suggests strong parallel forces are important in the evolution of both of these species.

Balazs, George H., Robert G. Forsyth, and Alan K. H. Kam. 1987. Preliminary assessment of habitat utilization by Hawaiian green turtles in their resident foraging pastures. NOAA-TM-NMFS-SWFC-71, 107 p.

Barss, William H., and Tina Wyllie Echeverria. 1987. Maturity of widow rockfish Sebastes entomelas from the northeastern Pacific, 1977-82, pp. 13-18. In William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

Gonad development, size, age, calculated weight at maturity, and fecundity for the widow rockfish (Sebastes entomelas) are reported. In 1977-82, a total of 3,636 specimens were examined from commercial trawl and partyboat sport catches off Oregon and California. Gonad development was earlier in southern latitudes. The principal months of parturition were February-March off Oregon and January-February off California. Mean size, age, and calculated mean weight at 50% maturity were 33 cm fork length (FL), 4 years of age, and 534 g for Oregon males, compared with 32 cm FL and 5 years for California males. Oregon females were 50% mature

at 38 cm FL, 7 years of age, and 937 g, as compared with 33 cm FL and 5 years for California females. Over 99% of the males and 92% of the females randomly sampled from Oregon landings were mature, compared with 93% males and 94% females from California landings. Fecundity increased with increasing length and ranged from 95,000 to 1,113,000 eggs in Oregon samples.

Boehlert, G. W. 1987. Meeting Reports: First Pacific Symposium on Marine Sciences. EOS Trans. Am. Geophys. Union 68:199.

Boggs, C. H., and S. G. Pooley. 1987. Forces of change in Hawaii's aku (skipjack tuna) industry, 1986 - workshop summary. NOAA-TM-NMFS-SWFC-72, 71 p.

Brill, R. W. 1987. On the standard metabolic rates of tropical tunas, including the effect of body size and acute temperature change. Fish. Bull., U.S. 85:25-35.

The standard metabolic rates (SMR's) of fishes and the effect of body weight on SMR's are important input parameters to energetics, growth, and population models. This study was undertaken to obtain these data for the tropical tuna species, yellowfin tuna, Thunnus albacares, and kawakawa, Euthynnus affinis. These data compliment similar SMR measurements from skipjack tuna, Katsuwonus pelamis, previously published. The effect of acute temperature change on the SMR of all three species was also determined.

The SMR was estimated by directly measuring the oxygen uptake rate of animals paralyzed with a neuromuscular blocking drug, rather than by the more commonly used method of extrapolation of swimming speed-metabolic rate curves back to zero swimming speed. To test the adequacy of this technique, the SMR's of aholehole, Kuhlia sandvicensis, and rainbow trout, Salmo gairdnerii, were determined using similar methodology. The SMR's measured in this way were not significantly different from the published SMR's of these species determined by extrapolation of swimming speed-metabolic rate curves back to zero swimming speed.

All three tuna species have very high SMR's, over five times higher than other active teleost species such as salmon and trout. The effect of body size on the SMR is similar in all three tuna species, but the weight specific SMR of tuna decreases more rapidly with increasing body size than in other fishes. Based on SMR's measured at 20°C and 25°C, the Q_{10}'s were 3.16 , 2.31, and 2.44 for yellowfin tuna, kawakawa, and skipjack tuna, respectively. These are similar to Q_{10} values found for the SMR's of other teleosts.

Tunas can achieve exceptionally high maximum aerobic metabolic rates. This ability requires a complete set of anatomical physiological, and biochemical adaptations. I

hypothesize that one of these adaptations, large gill surface areas, causes tunas to have exceptionally high energy demands even at rest. Tunas' high SMR's are an inevitable consequence of their ability to achieve exceptionally high maximum aerobic metabolic rates.

Cooperrider, Candis L. 1987. Commercial passenger fishing vessel landings of widow rockfish Sebastes entomelas in central California, pp. 49-52. In William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

Commercial fishing for widow rockfish (Sebastes entomelas) has increased significantly in northern and central California since the summer of 1981. In central California, widow rockfish are also found in commercial passenger fishing vessel landings. For this reason, the importance of widow rockfish to the central California recreational partyboat fishery was investigated during a 3-year study period from 1977 to 1979. Landings of widow rockfish by the recreational partyboat fishery were minor. Only 3.7% of the catch per unit of angling effort were widow rockfish. The catch of widow rockfish was greatest in northern ports and on trips taken during winter months. This rockfish may have been the target species of some winter recreational partyboat trips at San Francisco and Bodega Bay.

Johanos, Thea C., Alan K. H. Kam, and Robert G. Forsyth. 1987. The Hawaiian monk seal on Laysan Island: 1984. NOAA-TM-NMFS-SWFC-70, 38 p.

A study of the endangered Hawaiian monk seal, Monachus schauinslandi, was conducted on Laysan Island, in the Northwestern Hawaiian Islands, from 29 March to 7 August 1984. Pertinent population data from a short-term field camp lasting from 22 October to 6 November are also included.

Excluding pups, beach counts on 45 censuses conducted 7 May to 3 August ranged from 65 to 101 seals (average of 82). The entire subpopulation at Laysan Island (269 individual seals) was identified during 1984. At least 31 pups were born. Six seals (including 2 pups) either died or probably died during the 1984 field season, and at least 22 seals sustained injuries.

Two adult male mobbing incidents (collective acts of aggregation by adult male seals towards other individual seals where obvious injury is inflicted) were observed. Three single aggressive male incidents, where obvious injury is inflicted by a single male, were also observed. Fourteen seals were observed with dorsal wounds typical of bites inflicted by adult males during mating attempts, one of these seals subsequently died and two others disappeared.

At least 13 seals immigrated to or emigrated from Laysan Island between July 1983 and October 1984.

Lenarz, William H. 1987. Ageing and growth of widow rockfish, pp. 31-35. In William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

Surface examination of otoliths appears to be satisfactory for age determination of widow rockfish except for large specimens. The results indicate that one ring is laid down per year through age 10. Comparison of surface readings with sectioned readings from difficult-to-read otoliths indicates that surface readings are slightly lower than sectioned readings from such otoliths (3.0 years for males and 2.4 years for females). I recommend that surface readings not be used for males larger than 44 cm and females larger than 47 cm. Data from 2,003 females and 2,184 males were used to estimate the parameters of the von Bertalanffy growth curve.

Lenarz, William H., and Donald R. Gunderson (eds.). 1987. Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48, 57 p.

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Fisheries management decisions are usually predicated on affecting the supply of fish at the point of harvest. However, changes in supply may have significant impacts on processors, wholesalers, and the final consumer.

Examination of Hawaii's market for bottom fish shows some price volatility in the short run, and quality premiums in both the short and long run. Long-term demand has been significantly positive, most closely associated with increasing population, tourist arrivals, and exports. Fisheries management decisions must take into account the impact of changing supply conditions on the availability and price of fresh bottom fish in the market.

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Widow rockfish (Sebastes entomelas) was the most important West Coast groundfish species in 1980. Prior to 1978,

fishermen sold only limited amounts, never exceeding 1,000 MT. This paper predicts that sold landings of widow rockfish will expand to 25,000 MT and account for one-fourth of domestic landings by 1983. The possible reason why widow rockfish were not widely sold prior to 1979, why this fishery has developed and what may occur after 1983 are also discussed.

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